5NO4

1990500002.6 ?
entered OLD FWS

PRELIMINARY ASSESSMENT OF THE LONG ISLAND NATIONAL WILDLIFE REFUGE COMPLEX ENVIRONMENTAL CONTAMINANTS BACKGROUND STUDY FOURTH YEAR RESULTS

U.S.
FISH & WILDLIFE
SERVICE

DEPARTMENT OF THE INTERIOR

U.S. Fish and Wildlife Service
New York Field Office
3817 Luker Road
Cortland, New York 13045

PRELIMINARY ASSESSMENT
OF THE
LONG ISLAND NATIONAL WILDLIFE REFUGE
COMPLEX ENVIRONMENTAL CONTAMINANTS
BACKGROUND STUDY
FOURTH YEAR RESULTS

U.S. Fish and Wildlife Service
New York Field Office
3817 Luker Road
Cortland, New York 13045

August 1997

Preparer: David M. Edelstein
New York Field Supervisor: Sherry W. Morgan

EXECUTIVE SUMMARY

This report represents the results of the fourth year of the multi year study, the Long Island National Wildlife Refuge Complex (Complex) Environmental Contaminants Background Survey. The goal is to establish a baseline for future studies and to assist the managers in identifying potential impacts to fish and wildlife resources from environmental contaminants.

Sediment and soil were sampled in 1993 at two refuges, a wildlife management area, and an additional unit of the Complex: Conscience Point National Wildlife Refuge (NWR), Morton NWR, Lido Beach Wildlife Management Area (WMA), and the Sayville Unit. The samples were analyzed for inorganic and organic chemical residues. Six composite biological samples consisting of ribbed mussel (*Geukensia demissus*) and one composite sample of finfish from the families Belonidae, Cyprinodontidae, and Atherinidae were obtained from Conscience Point NWR, Morton NWR, and Lido Beach WMA to assess inorganic and organic chemical burdens in wildlife. In addition, Microtox® testing was performed on water, elutriate, and sediment samples from the sampling area.

Sediment collected from Conscience Point NWR in 1993 had levels of copper, cadmium, and chromium exceeding at least one of the concern levels reviewed. No polyaromatic hydrocarbons (PAH) concern levels were exceeded in any of the sediment samples from Conscience Point NWR in 1993. Total PCB's in sediment from Conscience Point NWR exceeded the New York State level of concern for human health bioaccumulation. Total DDT residues exceeded the New York State level of concern for human health bioaccumulation at all sample points, and some sample points exceeded the level of concern for benthic aquatic life chronic toxicity and wildlife bioaccumulation. One sample point exceeded the level of concern for benthic aquatic life acute toxicity in salt water.

Sediment collected from Morton NWR in 1993 had levels of cadmium, chromium, lead, copper, and nickel exceeding at least one of the concern levels reviewed. No PAH concern levels were exceeded in any of the sediment samples collected from Morton NWR in 1993. Total PCB's in sediment from some samples at Morton NWR exceeded the New York State level of concern for human health bioaccumulation. Total DDT residues exceeded the New York State level of concern for human health bioaccumulation at most sample points, and some sample points exceeded the level of concern for benthic aquatic life chronic toxicity and wildlife bioaccumulation. One sample point exceeded the level of concern for benthic aquatic life acute toxicity in salt water.

Sediment collected from Lido Beach WMA in 1993 had levels of arsenic, cadmium, chromium, lead, copper, mercury, and nickel exceeding at least one of the concern levels reviewed. No PAH concern levels were exceeded in any of the sediment samples collected from Morton Bay NWR in 1993. Total PCB's in sediment from two of the seven samples at Lido Beach WMA exceeded the New York State level of concern for human health bioaccumulation, and one exceeded the level of concern for wildlife bioaccumulation. Total DDT residues exceeded the New York State level of concern for human health bioaccumulation at most sample points, and one sample point exceeded the level of concern for benthic aquatic life chronic toxicity and wildlife bioaccumulation.

Soil samples were collected from the Sayville Unit in 1993. However, there are no guideline values for contaminant levels of concern in soil. Metals, PAH, PCB, and DDT/DDE/DDD residue levels were comparable to the lowest levels recorded for sediment at the other study locations.

All of the invertebrate tissue samples collected at Conscience Point and Morton NWR and Lido Beach WMA exceeded the predator protection levels for arsenic, 0.5 μg/g (Eisler 1986), cadmium, 0.5 μg/g (Eisler 1986), chromium, 0.2 μg/g (Eisler 1986), mercury, 0.1 μg/g (Eisler 1986), and selenium, 0.5 μg/g (Walsh et al. 1977).

The fish collected at Morton NWR exceeded the predator protection levels suggested for arsenic, 0.5 μg/g, chromium, 0.2 μg/g

(Eisler 1986), mercury, 0.1 μg/g (Eisler 1986), and selenium, 0.5 μg/g (Walsh et al. 1977).

The Microtox® testing indicated that elutriate samples from Conscience Point NWR had the most toxic response compared to Lido Beach WMA and Morton NWR. Seven of eleven samples from Conscience Point exhibited some toxicity, and five samples had EC_{50} values of $<10\%$ elutriate concentration. In contrast, only three of eight samples from Lido Beach and two of thirteen samples from Morton demonstrated toxicity. EC_{50}'s of elutriate from these locations was generally $>10\%$.

The 1993 sediment sampling results at Conscience Point NWR, Morton NWR, the Sayville Unit, and Lido Beach WMA are consistent with the 1990 and 1991 sampling results at Wertheim NWR and Oyster Bay NWR. There is a transport of contaminants onto these refuges. The biological uptake of the contaminants discovered in the sediment at both refuges needs to be better defined. Biological uptake will be discussed in a future report.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACKNOWLEDGMENTS

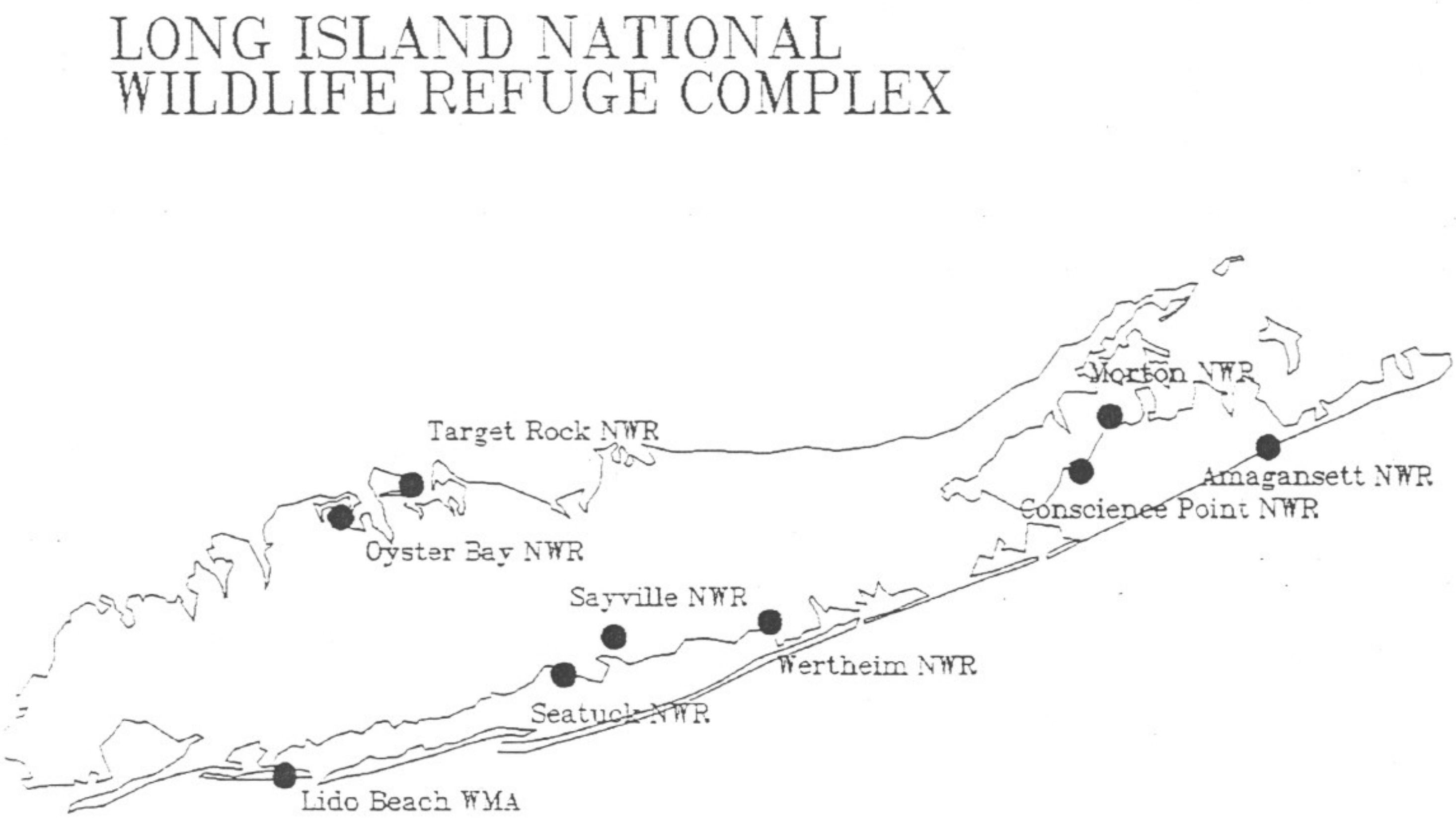
We gratefully acknowledge the help and support provided by Refuge Manager, Thomas Stewart and Assistant Refuge Manager, Barbara Pardo. We thank all of the Refuge personnel for their assistance in sample collection, especially William Kolodnicki and Bruce Marto without whose support and participation this study would not have been possible. We thank Volunteer Jason Ewanicki and Biologist Ken Karwowski for their assistance in sample collection.

INTRODUCTION

The United States Fish and Wildlife Service (Service) has been entrusted with the responsibility to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people. To meet this responsibility, the environmental health of the National Wildlife Refuge (NWR) System is being assessed to ensure the continued protection of fish and wildlife species utilizing the system. A multiyear study of the Long Island National Wildlife Refuge Complex (Complex) was initiated in 1990 to establish a baseline for future studies and to assist the managers in identifying potential impacts to fish and wildlife from environmental contaminants. This report represents the results of the 1992 sampling survey and provides a preliminary assessment of the contaminant burdens in sediments and biota. The Complex is the last of the three refuge systems in New York State to undergo a contaminants survey; Montezuma NWR and Iroquois NWR background surveys have been completed.

The Complex consists of one Wildlife Management Area, Lido Beach, and eight National Wildlife Refuges: Wertheim, Morton, Target Rock, Seatuck, Oyster Bay, Amagansett, Conscience Point, and Sayville (Fig. 1). Five of the properties were formerly private estates, three were transferred government properties, and one was donated primarily by a township. These properties are within a rapidly developing coastal region and have been described as "habitat islands" of regionally significant migratory bird stopover, breeding, and wintering habitats (Norton et al. 1984). The refuges provide habitat for several Federal and state designated endangered, threatened, and special concern species, such as the bald eagle (*Haliaeetus leucephalus*), roseate tern (*Sterna dougallii*), peregrine falcon (*Falco peregrinus*), piping plover (*Charadrius melodus*), least tern (*Sterna antillarum*), common tern (*Sterna hirundo*), osprey (*Pandion haliaetus*), Eastern bluebird (*Sialia sialis*), Northern harrier (*Circus cyaneus*), Eastern hognose snake (*Heterdon platyrhinos*), Eastern mud turtle (*Kinosternon subrubrum*), Kemp's ridley sea turtle (*Lepidochelys kempii*), loggerhead sea turtle (*Caretta caretta*), and sandplain gerardia (*Agalinis acuta*).

Figure 1.


LONG ISLAND NATIONAL
WILDLIFE REFUGE COMPLEX
Morton NWR
Target Rock NWR
Amagansett NWR
Conscience Point NWR
Oyster Bay NWR
Sayville NWR
Wertheim NWR
Seatuck NWR
Lido Beach WMA

Individual Refuges

Wertheim

Wertheim NWR, a private hunting estate, was acquired by gift of deed from Mauriće Wertheim on June 6, 1947. The refuge is bordered by the communities of South Haven, Brookhaven, and Shirley in the Town of Brookhaven in Suffolk County, New York (Fig. 2). Wertheim NWR consists of approximately 969 hectares of estuary and upland forest with the Carmans River, a New York State designated wild and scenic river, flowing through its center into Bellport Bay, the eastern most portion of Great South Bay. Habitats at Wertheim include bay, salt marsh, freshwater marsh, shrub swamp, mixed oak forest, oak-pine forest, and pitch pine forest. The refuge's wetlands provide habitat for breeding waterfowl, especially for wood ducks (*Aix sponsa*), American black ducks (*Anas rubripes*), gadwalls (*Anus strepera*), and mallards (*Anas platyrhynchos*). The Carmans River estuary is an important waterfowl wintering area as it is one of the last areas to freeze on Long Island during periodic cold winters. Waterfowl overwintering in this estuary include American black duck, gadwall (*Anas strepera*), bufflehead (*Bucephala albeola*), mallard, hooded merganser (*Lophodytes cucullatus*), red-breasted merganser (*Mergus serrator*), greater scaup (*Aythya marila*), and green-winged teal (*Anas crecca*). Eleven long-legged wading bird species have been documented at Wertheim including American bittern (*Botauus lentiginosus*) and least bittern (*Ixobrychus exilis*), both New York State species of concern. Three pairs of osprey nest on the refuge and Northern harriers are common all year, both New York State designated threatened species. Many species of raptors use Wertheim during migration; most noticeable are sharp-shinned hawks (*Accipiter striatus*), Cooper's hawks (*A. cooperii*), American kestrels (*Falco sparverius*), merlins (*F. columbarius*), and peregrine falcons. Bald eagles occur occasionally during the winter months. The refuge forest is large and diverse enough to support forest interior breeding birds and most dependent forest avian species known to occur on Long Island. Most species of mammals, reptiles, amphibians, and fish known to occur on Long Island are present at the refuge. The largest population in New York of the Eastern mud turtle, a New York State listed endangered species, is present at Wertheim.

A viable brook trout (*Salvelinus fontinalis*) population occurs on the refuge, one of only seven on Long Island, and the Carmans River is a significant habitat for yearling striped bass (*Morone saxatilis*) as well as other estuary dependent fish and shellfish.

<u>Elizabeth A. Morton NWR</u>

Elizabeth A. Morton NWR, a private estate, was acquired by gift of deed from Elizabeth A. Morton on December 27, 1954. Morton NWR is in the community of Noyack in the Town of Southampton in Suffolk County, New York (Fig. 3). The refuge consists of Jessup's Neck peninsula and adjacent lands on Long Island's south fork, approximately 75 hectares in size. The peninsula, a prominent feature of Peconic Bay, consists of three miles of undeveloped shoreline principally sand beach dominated by American beachgrass (*Ammophila breviligulata*), beach plum (*Prunus maritima*), *Viburnum* thickets, red cedar (*Juniperus virginiana*), and oak (*Quercus* spp.). Habitats at the refuge include marine beach, salt marsh, freshwater marsh, brackish and freshwater ponds, lagoon, tidal flat, old field, and deciduous forest. Over 252 avian species have been documented at the refuge, of which 90 species have been identified as breeders including Federally listed threatened piping plovers, New York State listed endangered least terns, and osprey. There has been as many as 40 piping plovers using the refuge as a post-breeding staging area. The peninsula also acts as a staging area for the Federally listed endangered roseate tern. Common wintering waterfowl include white-winged scoter (*Melanitta fusca*), oldsquaw (*Clangula hyemalis*), common goldeneye (*Bucephala clangula*), red-breasted merganser, and American black duck. The bays surrounding the refuge provide important migration and/or winter habitat for common loons (*Gavia immer*), double-crested cormorants (*Phalacrocorax auritus*), and horned grebes (*Podiceps auritus*). The north-south axis of the peninsula between Long Island's two forks also makes Morton an important migration corridor for a variety of terrestrial avian species. In addition, the refuge provides habitat for 21 species of mammals and 24 species of reptiles and amphibians including loggerhead sea turtles and Kemp's ridley sea turtles, Federally listed as threatened and endangered species, respectively.

Figure 2.

WERTHEIM NATIONAL WILDLIFE REFUGE

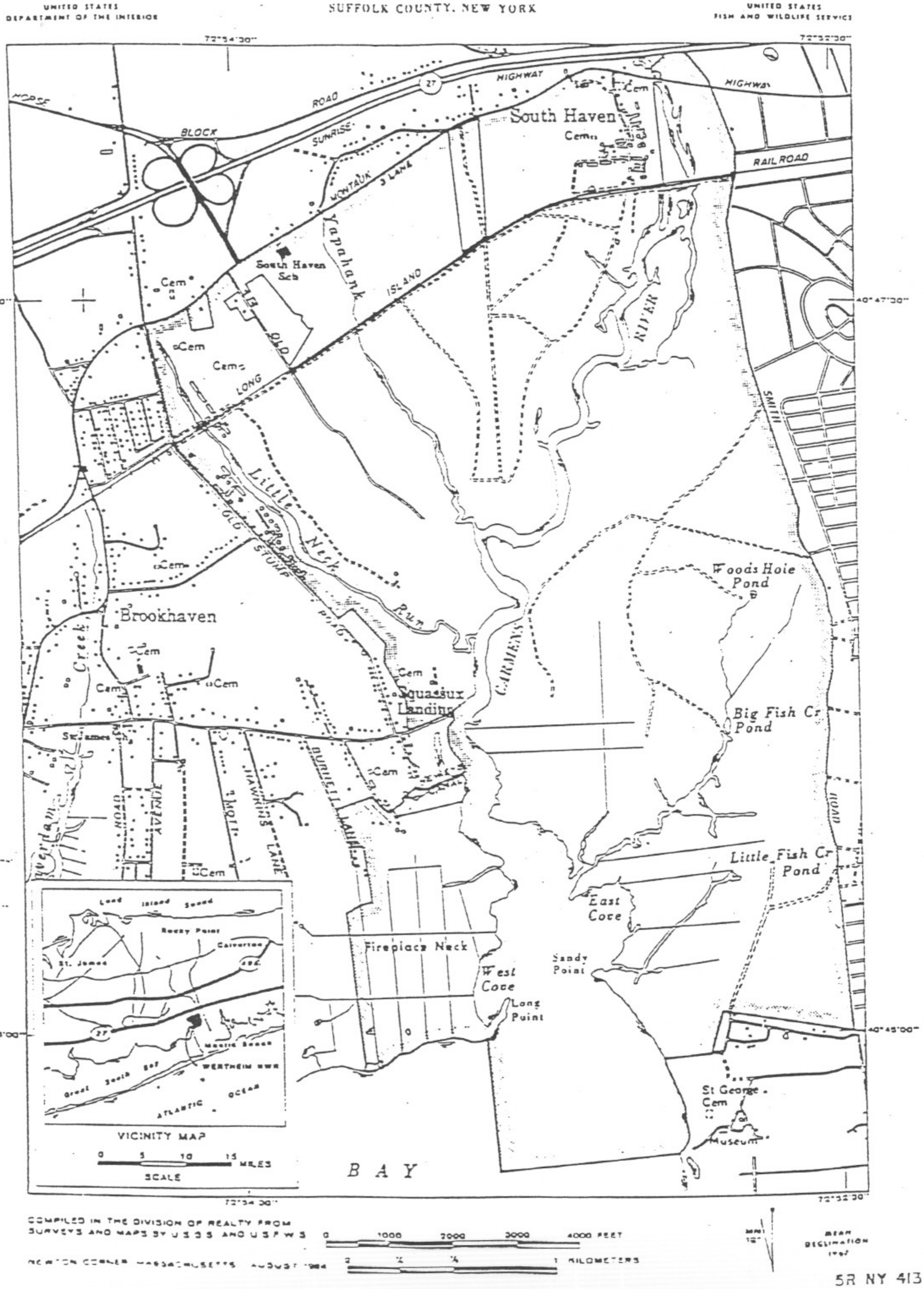
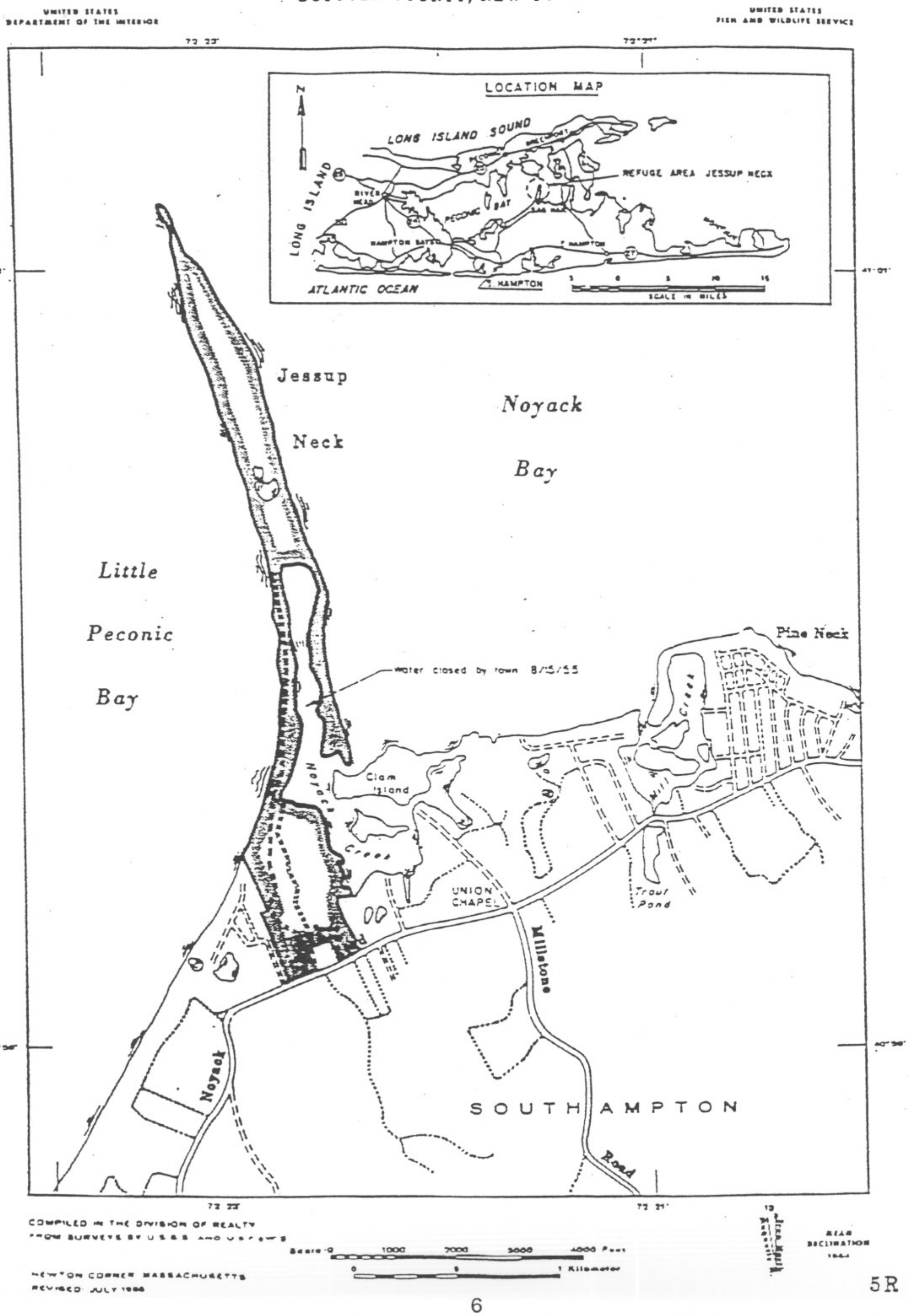


Figure 3. ELIZABETH A. MORTON NATIONAL WILDLIFE REFUGE

SUFFOLK COUNTY, NEW YORK



5R NY 46

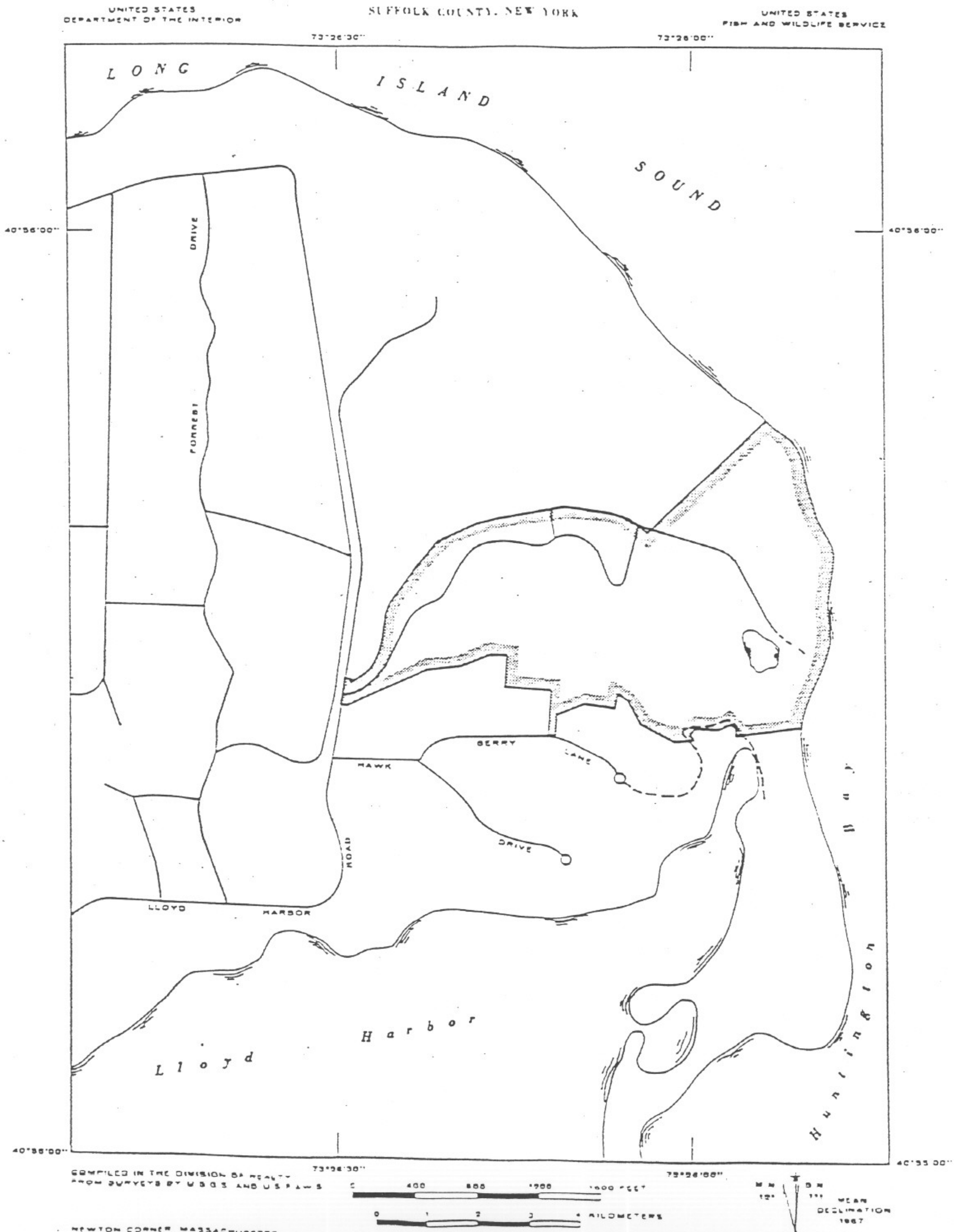
Target Rock NWR

Target Rock NWR, a private estate with extensive horticultural activities, was acquired from Mary Eberstadt on December 15, 1967. The refuge is bordered by the community of Lloyd Harbor in the Town of Huntington in Suffolk County, New York (Fig. 4). Target Rock NWR consists of approximately 30 hectares of upland and rocky coast on Huntington Bay of Long Island Sound. The refuge provides excellent food and cover for nesting and migrating birds. The chestnut oak (*Quercus prinus*) and red oak/mountain laurel (*Quercus rubra/Kalmia latifolia*) association offers habitat for migrating neotropical migrant birds. Invertebrate populations at the refuge's offshore beach and pond habitats provide foraging areas for piping plovers, wintering waterfowl, and fish such as bluefish (*Pomatomus saltatrix*) and striped bass, and lobster (*Homarus americanus*). Common waterfowl species in winter include American black duck, greater scaup (*Aythya marila*), oldsquaw, red-breasted merganser, and common goldeneye. Long-legged wading birds are common in the marsh with common and least terns foraging along the beach. Over 240 avian species have been documented at the refuge as well as 30 species of mammals, 10 species of reptiles, and 3 species of amphibians. Marine mammals, notably harbor seals (*Phoca vitulina*), and sea turtles, have used the protected coastline of Target Rock NWR for foraging and resting.

Seatuck NWR

Seatuck NWR, a private farm, was acquired as a gift of deed from Natalie Peters and Natalie Webster on September 26, 1968. The refuge is in the Town of Islip in Suffolk County, New York (Fig. 5). Seatuck NWR consists of approximately 75 hectares of salt marsh and upland with Champlin Creek to the east, the Audubon Scully Sanctuary to the west, and Great South Bay as its southern boundary. Suburban development borders the remainder of the refuge. A project to restore the salt marsh at Seatuck that reestablished the tidal flow between the bay and marsh was completed during the spring of 1992 and will serve as a prototype for other such restoration projects on Long Island. Over 243 avian species have been documented at the refuge. Three pairs of osprey nest at

Figure 4. TARGET ROCK NATIONAL WILDLIFE REFUGE



SR N.Y. 791

Figure 5.

SEATUCK NATIONAL WILDLIFE REFUGE

Suffolk County, New York

UNITED STATES
DEPARTMENT OF THE INTERIOR

UNITED STATES
FISH AND WILDLIFE SERVICE

COMPILED IN THE DIVISION OF ENGINEERING
FROM SURVEYS BY G. S. AND F. & W. S.

BOSTON, MASSACHUSETTS FEBRUARY 1973

Scale 0 400 800 1200 1600 Feet

MEAN DECLINATION 1967

5R NY 810

Seatuck and wading birds and sandpipers are common in the marsh. Waterfowl are common in the marsh and surrounding waters; American black ducks are the predominant species. The refuge attracts numerous raptor migrants because of its isolated nature, particularly merlin, kestrel, sharp-shinned hawk, Cooper's hawk, and peregrine falcon. Seatuck also supports the western most white-tailed deer (*Odocoileus virginianus*) herd on Long Island.

Amagansett NWR

Amagansett NWR was transferred to the Service from the United States Coast Guard on December 16, 1968. The refuge is in the community of Amagansett in the Town of Easthampton in Suffolk County, New York (Fig. 6). Amagansett NWR is one segment in a 25 mile continuous barrier beach extending from Georgia Pond to Montauk Point. The refuge consists of a marine beach, primary dune, a secondary dune/swale complex, and scrub oak (*Quercus ilicifolia*) vegetation. The refuge totals 15 hectares including a 1,342 feet stretch of Atlantic Ocean barrier beach. The primary dune line averages ten to fifteen feet in height and is largely intact, dominated by beach grass. Vegetation present on secondary dunes include beach pea (*Lathyrus japonicus*), dusty miller (*Arthemisia stelleriana*), seaside goldenrod (*Solidago sempervirens*), bearberry (*Arctostaphylos* sp.), and extensive areas of false heather (*Hudsonia tomentosa*). Also behind the foredunes are areas of poison ivy (*Toxicodendron radicans*), beach plum, bayberry (*Myrica* sp.), orchid species, and wild rose (*Rosa* sp.). This area grades into several small bogs which support cranberry (*Vaccinium* sp.), sundew (*Drosera* sp.), sedges (*Carex* spp.), and various grasses. The most inland portion of Amagansett consists of patches of scrub oak, chokecherry (*Prunus virginiana*), bayberry, beach plum, wild rose, and red cedar. The refuge is of special significance in the protection and management of fragile shore habitats and its associated wildlife. Amagansett serves an important function for raptors which migrate along the coast. Kestrels, merlins, peregrine falcons, sharp-shinned hawks, and Cooper's hawks occur during migration. Snowy owls (*Nyctea scandiaca*) and rough-legged hawks (*Buteo lagopus*) have been documented on the refuge during winter months. The marine beach and swales provide habitat for a variety of sandpipers, plovers, gulls, and terns. The rare Ipswich sparrow (*Passerculus princeps*) has been documented in winter on the refuge and at adjacent lands. The Eastern hognose snake, a New York State special concern species which is declining on Long Island, is common on the refuge.

Oyster Bay NWR

Oyster Bay NWR was deeded to the Service with provisions by the Town of Oyster Bay on December 18, 1968. The Town of Oyster Bay retains the mineral rights, limited mooring facilities, and aquaculture regulation in the bay. The refuge is located within the Town of Oyster Bay in Nassau County, New York (Fig. 7). Oyster Bay NWR consists of 1305 hectares of bay bottom and salt marsh including most of Oyster Bay proper, Mill Neck Creek, a portion of Frost Creek, and a portion of Cold Spring Harbor. Invertebrates and shellfish are abundant, providing food for large concentrations of migrating and wintering waterfowl; in 1991 there were 20,350 birds. The most common species include greater scaup, American black duck, bufflehead, canvasback (*Aythya valisineria*), and oldsquaw. The tidal marshes at Mill Neck Creek and Frost Creek provide breeding habitat for American black ducks, clapper rails (*Rallus longirostris*), and osprey. Over 234 avian, 30 marine fish, 300 phytoplankton, and 40 marine invertebrate species have been documented at Oyster Bay. Sightings of peregrine falcons and bald eagles are not uncommon. Kemp's ridley sea turtles and unusually large numbers of diamondback terrapins (*Malaclemys terrapin*), a New York State special concern species, use the refuge during the year. The only remaining commercial oyster farm in New York State operates at Oyster Bay and supplies 90% of the state's oyster harvest. Marine mammals including harbor seals and harbor porpoises (*Phocoena phocoena*) area routinely sighted.

Lido Beach Wildlife Management Area

Lido Beach Wildlife Management Area (WMA) was transferred to the Service from the United States Department of Army, Corps of Engineers, on October 21, 1969. Lido Beach WMA consists of approximately 10 hectares of salt marsh and upland on the Long Beach

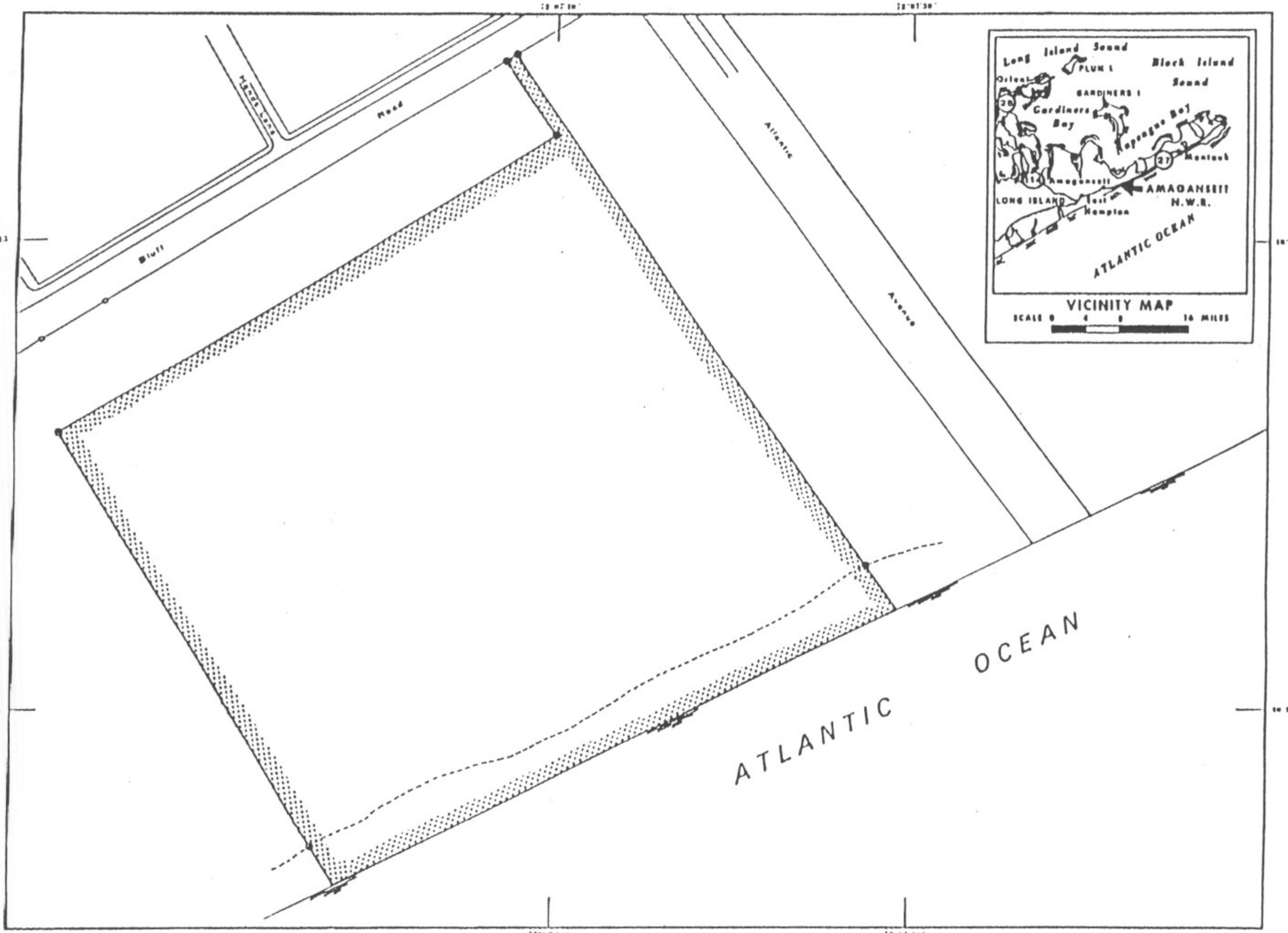
AMAGANSETT NATIONAL WILDLIFE REFUGE

SUFFOLK COUNTY, NEW YORK

UNITED STATES
DEPARTMENT OF THE INTERIOR

UNITED STATES
FISH AND WILDLIFE SERVICE

Figure 6.



COMPILED IN THE DIVISION OF REALTY
FROM SURVEYS BY THE U.S.G.S. AND THE U.S.F.&W.S.

NEWTON CORNER MASSACHUSETTS
REVISED JULY,1986

SCALE 0 150 300 450 600 FEET

0 50 100 150 200 METERS

13° Magnetic N True North

MEAN DECLINATION 1986

5R N.Y. 805

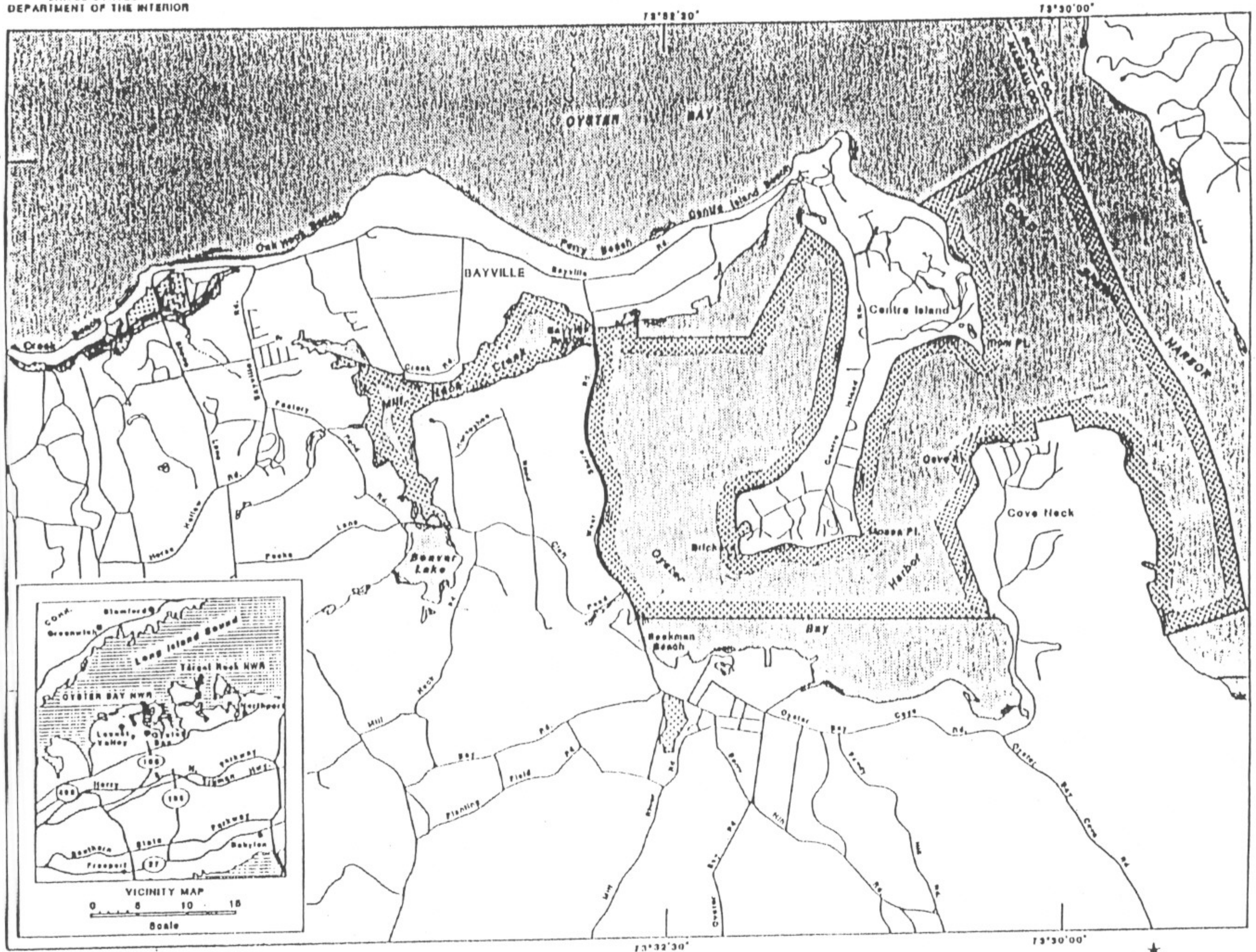
OYSTER BAY NATIONAL WILDLIFE REFUGE

NASSAU COUNTY, NEW YORK

UNITED STATES
DEPARTMENT OF THE INTERIOR

UNITED STATES
FISH AND WILDLIFE SERVICE

Figure 7.



COMPILED IN THE DIVISION OF REALTY
FROM SURVEYS BY U.S.G.S. AND SURVEYS
BY THE U.S.F. & W.S.

NEWTON CORNER, MASSACHUSETTS JANUARY 1970

0 2000 4000 6000 8000 FEET

0 .5 1 1.5 2 KILOMETERS

MEAN
DECLINATION
1967

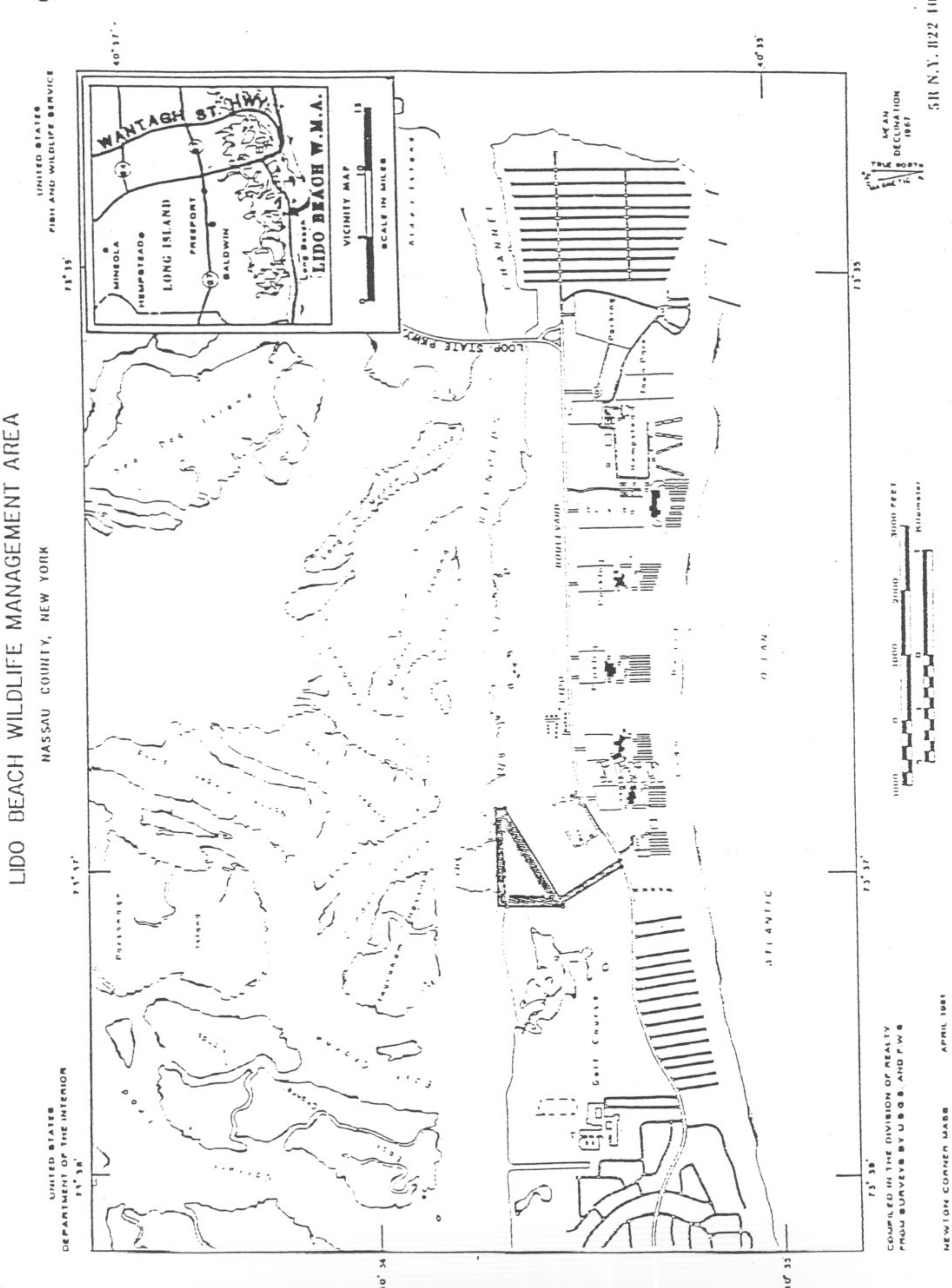
5R NY 8

barrier island between Reynolds Channel and the Atlantic Ocean. The area is bordered on the west by the Lido Golf Club and on the north by Reynolds Channel within the community of Lido Beach in the Town of Hempstead in Nassau County, New York (Fig. 8). The salt marsh borders Hempstead Bay and consists of intertidal and high marsh. Two mud flats are present on the marsh. The salt marsh and adjacent bay provide habitat for waterfowl, wading birds, and shorebirds. American black duck, bufflehead, red-breasted merganser, and brant (*Branta bernicla*) are the most common waterfowl during the winter. The shrub thickets provide roosting habitat for a variety of long-legged wading birds, in particular black-crowned night herons (*Nycticorax nycticorax*). Hempstead Bay is known for its concentrations of shorebirds during migration. Willets (*Catoptrophorus semipalmatus*), whimbrels (*Numenius phaeopus*), oystercatchers (*Haematopus* spp.), and glossy ibises (*Plegadis falcinellus*) have been observed at the Management Area. Northern harriers are routinely observed at Lido Beach.

<u>Conscience Point NWR</u>

Conscience Point NWR, a private estate, was acquired by gift of deed from Stanley Howard on July 20, 1971. The refuge is within the community of North Sea in the Town of Southampton in Suffolk County, New York (Fig. 9). Conscience Point consists of approximately 25 hectares of salt marsh, tidal ponds, and upland with the North Sea Harbor as its eastern border. The uplands of the refuge include a maritime grassland, one of only three such areas remaining on Long Island. The maritime grassland is a regionally significant plant community, usually located on outwash plains near the ocean or bays. The dominant vegetation includes bluestem (*Andropogon* sp.), hairgrass (*Deschampsia* sp.), poverty oatgrass (*Danthonia spicata*), and prickly pear (*Opuntia humifusa*). Conscience Point supports several species of waterfowl mainly American black duck, bufflehead, and red-breasted merganser with black ducks comprising the majority. Long-legged wading birds are common in the winter and waterbirds such as double-crested cormorants, horned grebes, and clapper rails also use the refuge. Ospreys and Northern harriers are routinely observed.

Figure 8.



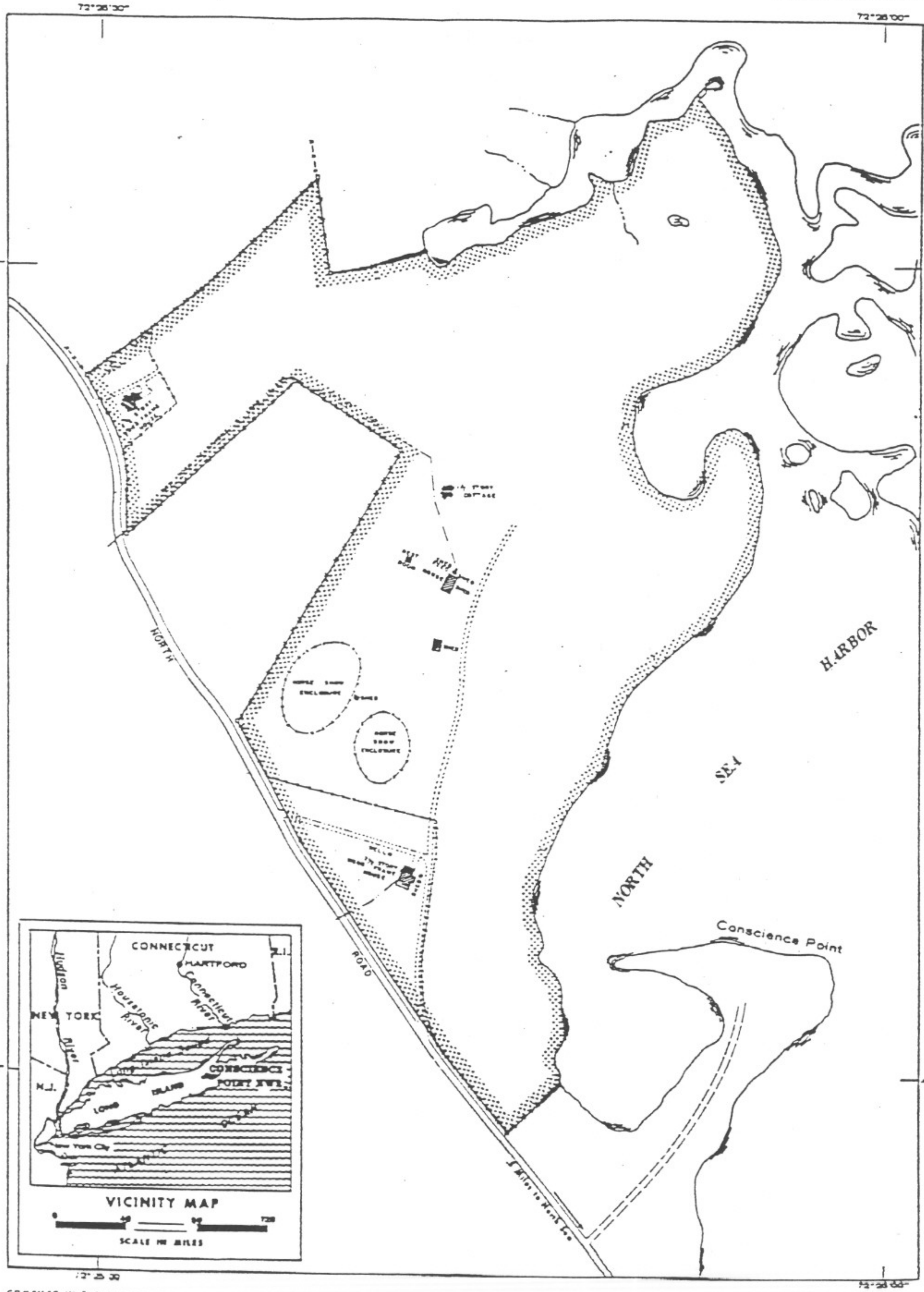
LIDO BEACH WILDLIFE MANAGEMENT AREA
NASSAU COUNTY, NEW YORK
UNITED STATES
FISH AND WILDLIFE SERVICE
UNITED STATES
DEPARTMENT OF THE INTERIOR
WANTAGH ST. HWY.
MINEOLA
HEMPSTEAD
LONG ISLAND
FREEPORT
BALDWIN
LIDO BEACH W.M.A.
VICINITY MAP
SCALE IN MILES
LOOP STATE PKWY.
CHANNEL
BOULEVARD
Golf Course
ATLANTIC OCEAN
MEAN DECLINATION 1967
3000 FEET
Kilometer
COMPILED IN THE DIVISION OF REALTY
FROM SURVEYS BY U.S.G.S. AND F.W.S.
APRIL 1981
NEWTON CORNER MASS

Figure 9. CONSCIENCE POINT NATIONAL WILDLIFE REFUGE

SUFFOLK COUNTY, NEW YORK

UNITED STATES
DEPARTMENT OF THE INTERIOR

UNITED STATES
FISH AND WILDLIFE SERVICE



COMPILED IN THE DIVISION OF REALTY
FROM SURVEYS BY U.S.G.S. AND U.S.F.&W.S.

SCALE 0 200 400 600 800 FEET

0 1 2 KILOMETERS

MEAN DECLINATION 1966

BOSTON, MASSACHUSETTS JUNE 1970.

5R NY 835

Sayville NWR

Sayville NWR was transferred to the Service from the Federal Aviation Administration on April 8, 1992. Presently, Sayville consists of approximately 10 hectares of potential habitat for sandplain gerardia (*Agalinis acuta*), a Federally listed endangered plant species. The species has been found at only twelve coastal locations. An addition of approximately 41 hectares adjacent to this refuge is proposed where a sandplain geradia population is being managed. Sandplain gerardia is also managed on adjacent lands through partnerships. The refuge is within the community of West Sayville in the Town of Islip in Suffolk County, New York (Fig. 10).

MATERIALS AND METHODS

SAMPLE SITE LOCATIONS

Sampling was broken into three phases. First, a site survey was conducted at each refuge to identify areas most likely to be contaminated. Sites with the following characteristics were targeted: 1) proximity to possible contaminant sources, 2) predominantly fine textured or organic sediments, 3) low-lying or depressional areas, and 4) dying vegetation or abiotic zones. Samples were then taken from sites having such features and tested using Microtox® bioassay procedures. Finally, results of the Microtox® testing were used to develop and refine further sample locations.

Microtox® testing

Microtox® testing was performed on water, elutriate, and sediment samples obtained from Conscience Point NWR, Morton NWR, and Lido Beach WMA (Tables 16-19). Water samples were taken by submerging a sampling bottle in the water column in depressions in the bottom sediment. Sample size was 125 milliliters. Elutriate or sediment samples (250 ml) were collected from the upper sediments using a hand trowel or a stainless steel auger. When possible, salinity and

Figure 10.

Sayville National Wildlife Refuge
ISLAND HILLS COUNTRY CLUB
OAKDALE
WEST SAYVILLE
LA SALLE MILITARY ACADEMY
NICOLL BAY
WEST SAYVILLE BEACH
SAYVILLE BEACH
Green Pt.
Timber Pt.
Brown Pt.
1782
1796
1769
N

water temperature readings were taken using YSI calibrated salinity and dissolved oxygen meters. All samples were placed on ice within one hour of collection and shipped by overnight mail to the New York Field Office in Cortland, New York, for testing.

Sediment and Soil Samples:
Thirty composite samples were collected within the Conscience Point NWR, Morton NWR, Lido Beach WMA, and the Sayville Unit in Summer, 1993 (Figs. 11, 13, 15, and 16). Samples were a composite of five subsamples which were positioned to achieve maximal areal coverage within a habitat type. Collection was performed using either a stainless steel petite Ponar Dredge, hand auger, or shovel.

The upper 10-20 cm of substrate was sampled using standard protocols (Appendix A). Subsamples were composited by mixing in a stainless steel bucket. To the extent possible, undecomposed detrital matter and large pebbles were removed. Three aliquots of approximately 700 g each were sampled for analysis of organic and inorganic residues, grain size composition, and total organic carbon.

Biological Samples:
Seven composite biological samples consisting of ribbed mussels (*Geukensia demissus*) and finfish from the families Belonidae, Cyprinodontidae, and Atherinidae were obtained from Conscience Point NWR, Morton NWR, and Lido Beach WMA. Figures 12, 14, and 15 provide the sampling locations, which were positioned to coincide with sediment sampling sites. Fish were sampled with a beach haul; mussels were collected by hand in the meso-intertidal zone. All biological samples were placed on ice within an hour of collection.

An ample supply of mussels and fish were collected to ensure the availability of at least 25 g of tissue for analysis. Mussel soft tissue was extracted using a stainless steel knife. Decontamination procedures given in Appendix A were followed between samples. All biological samples were placed in a conventional freezer at the Long Island Field Office until shipped to the contracted laboratory.

Table 16. Locations of Microtox® samples collected from the Long Island National Wildlife Refuge Complex in 1993

SAMPLE NUMBER	DATE	LOCATION
CPMTX01A/CPMTX01B	6/23/93	Freshwater pond/wetland
COMTX02	6/23/93	shoreline central eastern shore bordering North Sea Harbor
CPMTX03A	6/23/93	westernmost ditch - NW marsh
CPMTX03B	6/23/93	tidal pool - central NW marsh
CPMTX03C	6/23/93	easternmost ditch - NW marsh
CPMTX04A	6/23/93	north ditch - NE marsh
CPMTX04B	6/23/93	south ditch - NE marsh
CPMTX05A	6/23/93	northern shoreline - NE marsh
CPMTX05B	6/23/93	shoreline of embayment bordering North Sea Harbor
CPMTX05C	6/23/93	southeastern shoreline bordering North Sea Harbor
LBMTX01	6/28/93	tidal pool - NW corner of marsh
LBMTX02	6/28/93	ditch confluence - NW marsh
LBMTX03	6/28/93	terminus of cul-de-sac ditch - NW marsh
LBMTX04	6/28/93	mud flat directly south of LBMTX03
LBMTX05	6/28/93	small N-S dotch, ~100 feet south of Reynolds Channel
LBMTX06	6/28/93	mud flat - central marsh
LBMTX07	6/28/93	drainage area north of LBMTX08
LBMTX08	6/28/93	shoreline tidal pool - SE corner of property
LBMTX09	6/28/93	shoreline of E-W ditch in the vicinity of south foot bridge
LBMTX10A/LBMTX10B	6/28/93	shoreline of E-W ditch at south foot bridge

Table 16 (Continued)

SAMPLE NUMBER	DATE	LOCATION
MTMTX01A/MTMTX01B	7/13/93	E-W ditch in SE wetland
MTMTX02A/MTMTX02B	7/13/93	North edge of freshwater pond
MTMTX03A/MTMTX03B	7/13/93	Small freshwater pool on SE side of property, ~20 feet south of Noyack Rd.
MTMTX04	7/14/93	northern edge of brackish pond
MTMTX05	7/14/93	southern edge of brackish pond
MTMTX06A/MTMTX06B	7/14/93	shoreline north end of Lagoon
MTMTX07A/MTMTX07B	7/14/93	western shore Noyack Creek
MTMTX08	7/14/93	marsh drainage located across from Clam Island

Table 17. Microtox® 5, 15, and 30 minute EC_{50}'s for elutriate samples collected from Conscience Point National Wildlife Refuge in 1993*

Sample	Salinity	5 min.	15 min.	30 min
CPMTX01A	0 ppt	6.09% (5.17-7.17)	5.49% (4.14-7.29)	9.56% (8.55-10.68)
CPMTX01B	0 ppt	13.08 (10.15-16.84)	11.04 (9.16-13.31)	67.95 (29.24-157.1)
CPMTX02	15 ppt	>100	>100	>100
CPMTX03A	9 ppt	5.51 (5.25-5.79)	6.40 (6.17-6.63)	8.87 (8.12-9.69)
CPMTX03B	13 ppt	1.44 (1.15-1.81)	1.36 (1.02-1.80)	1.29 (0.17-9.70)
CPMTX03C	29 ppt	23.10 (21.67-24.62)	20.42 (19.57-21.30)	19.79 (19.28-20.31)
CPMTX04A	13 ppt	2.85 (2.57-3.12)	3.15 (2.97-3.35)	3.91 (3.89-3.93)
CPMTX04B	15 ppt	5.27 (4.64-5.99)	4.88 (4.13-5.77)	4.27 (2.77-6.60)
CPMTX05A	20 ppt	>100	>100	>100
CPMTX05B	26 ppt	>100	>100	>100
CPMTX05C	25 ppt	>100	>100	>100

* - 95% confidence intervals in parentheses

Table 18. Microtox® 5, 15, and 30 minute EC_{50}'s for elutriate and 5 minute EC_{50}'s for sediment samples collected from Lido Beach Wildlife Management Area in 1993*

Sample	Salinity	5 min.	15 min.	30 min
LBMTX01	38 ppt	>100	>100	>100
LBMTX02	29 ppt	>100	>100	>100
LBMTX04	32 ppt	>100	>100	>100
LBMTX05	31 ppt	11.90 (10.84-13.07)	7.10 (3.72-13.58)	9.73 (5.14-18.43)
LBMTX06	>40 ppt	1.47 (0.62-3.51)	ND	11.39 (10.91-11.89)
LBMTX07	32 ppt	>100	>100	>100
LBMTX08	38 ppt	33.85 (30.38-37.70)	39.96 (37.64-42.42)	62.76 (56.13-70.17)
LBMTX09	27 ppt	>100	>100	>100
LBMTX03	sediment	1.49 (1.27-1.75)	ND	ND
LBMTX10A	sediment	9.73 (5.72-16.56)	ND	ND
LBMTX10B	sediment	2.33 (2.13-2.55)	ND	ND

* - 95% confidence intervals in parentheses
ND - No Data

Table 19. Microtox® 5, 15, and 30 minute EC_{50}'s for elutriate samples collected from Morton National Wildlife Refuge in 1993*

Sample	Salinity	5 min.	15 min.	30 min
MTMTX01A	0 ppt	>90	>90	>90
MTMTX01B	0 ppt	>90	>90	>90
MTMTX02A	0 ppt	29.36 (26.25-32.83)	28.47 (25.61-31.65)	26.64 (24.14-29.39)
MTMTX02B	0 ppt	14.82 (13.72-16.01)	18.24 (16.64-20.00)	21.43 (20.15-22.79)
MTMTX03A	0 ppt	>90	>90	>90
MTMTX03B	0 ppt	>90	>90	>90
MTMTX04B	40 ppt	>100	>100	>100
MTMTX05	>40 ppt	>90	>90	>90
MTMTX06A	25 ppt	>100	>100	>100
MTMTX06B	25 ppt	>100	>100	>100
MTMTX07A	14 ppt	>100	>100	>100
MTMTX07B	14 ppt	>100	>100	>100
MTMTX08	0 ppt	>90	>90	>90

* - 95% confidence intervals in parentheses

Figure 11. Sediment and soil sample sites at Conscience Point National Wildlife Refuge

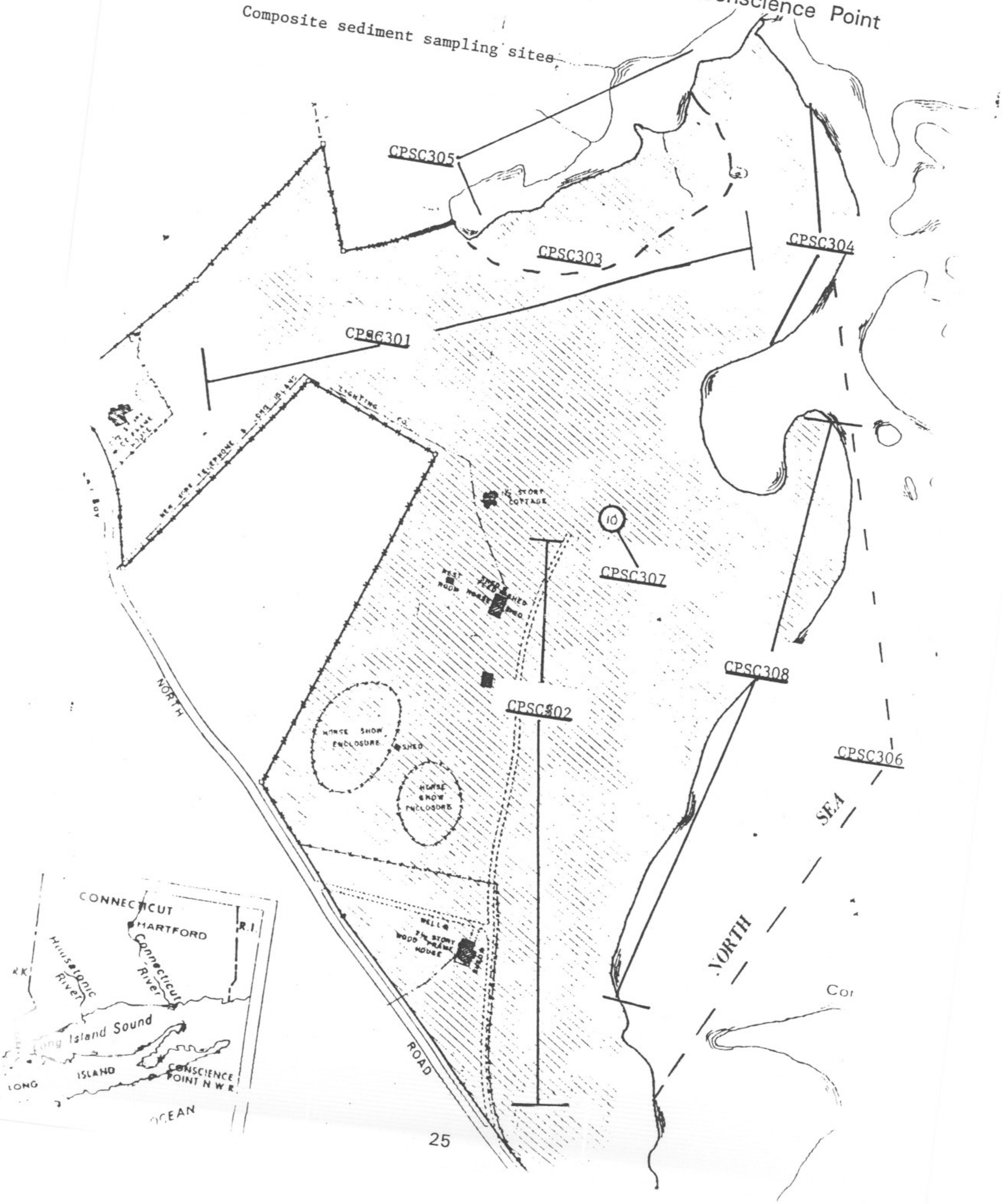
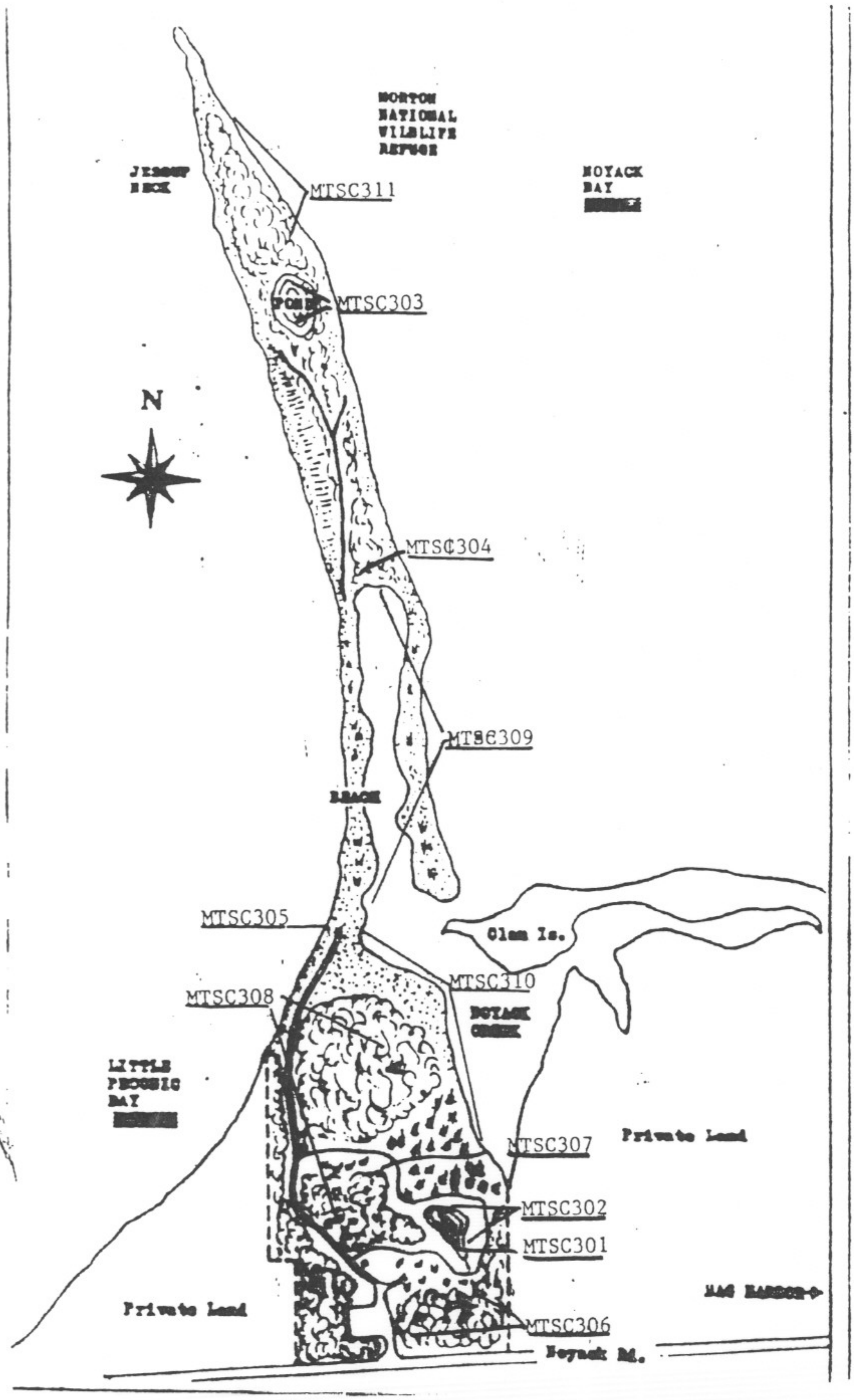


Figure 13. Sediment and soil sample sites at Morton National Wildlife Refuge



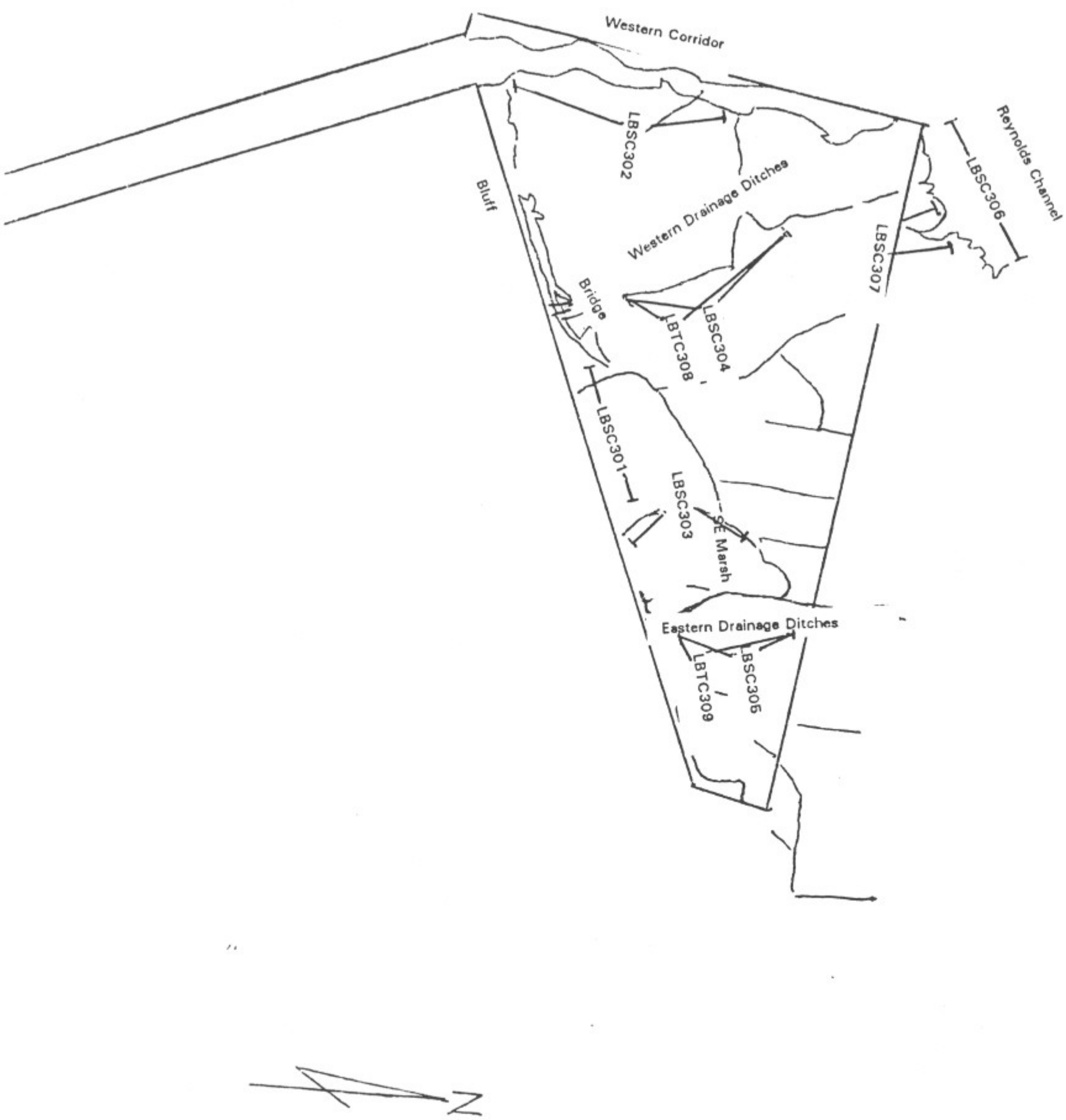


Figure 15. Sediment, soil and composite tissue sample sites at Lido Beach Wildlife Management Area

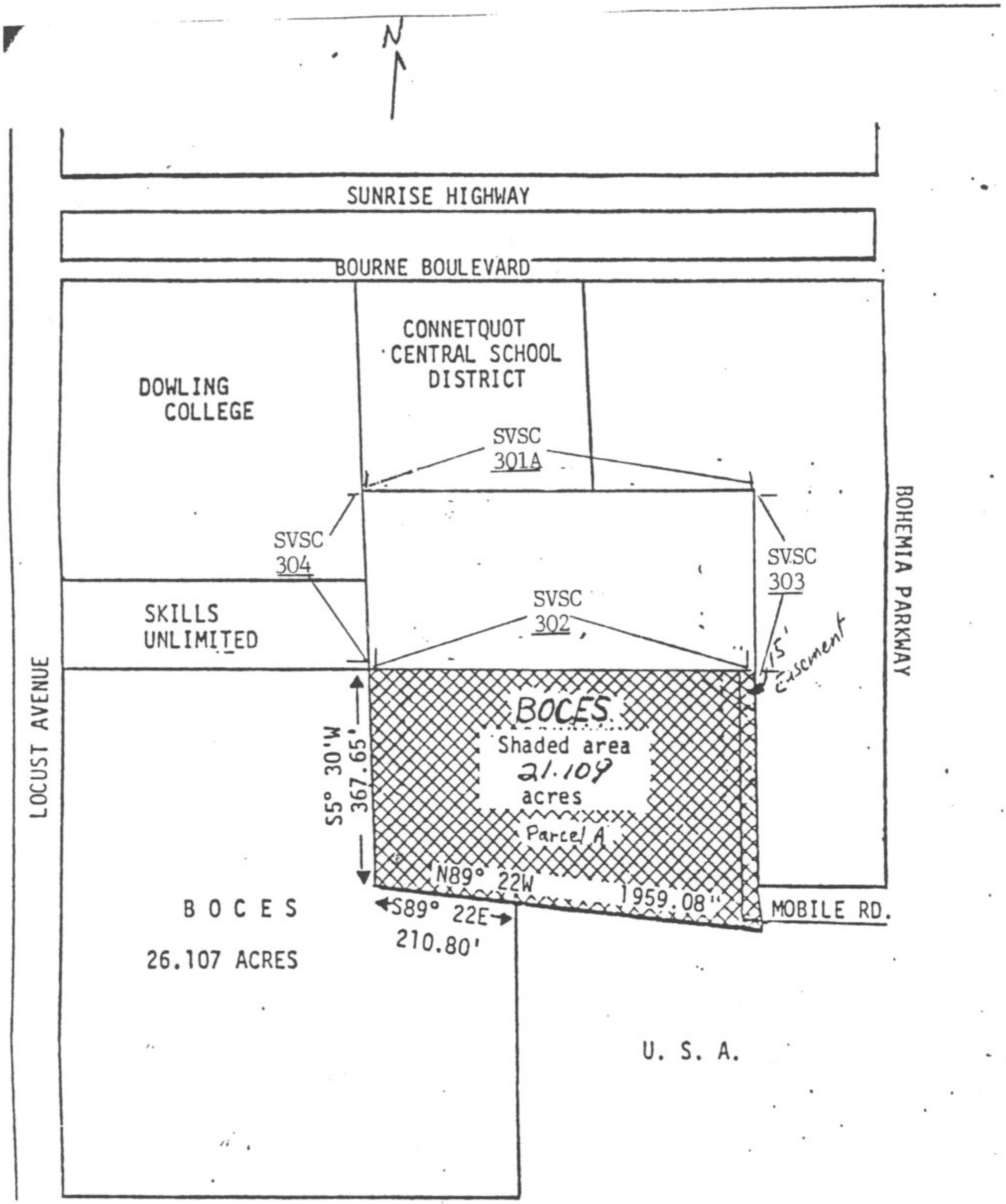


Fig. 16: Soil samples sites at the Sayville Unit

LABORATORY ANALYSIS

The analyses of all samples for metals and soil/sediment grain size were performed following Service contractual specifications at Research Triangle Institute. The analyses of all samples for aliphatic hydrocarbons, polyaromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), organochlorine pesticides, and soil/sediment total organic carbon were performed following Service contractual specifications at the Geochemical and Environmental Research Group of Texas A&M University. Quality assurance/quality control (QA/QC) for the analytical techniques used by the contract laboratory was established and overseen by Patuxent Analytical Control Facility (PACF).

RESULTS

There were 19 inorganic residues, 25 aliphatic compounds, 20 PCB, 15 organochlorine compounds, and 45 PAH analyzed in sediment and soil samples (Table 1). However, only 3 invertebrate samples, 5 sediment samples, and 1 soil sample were subjected to all analyses. Aliphatic hydrocarbons, PAH, and organochlorine compounds were found in all of the tested samples. Inorganic residues in soil and sediment were widespread, with the following exceptions: mercury was only found at Lido Beach, boron and molybdenum were below the level of detection at Sayville, and selenium was below the level of detection at Conscience Point and Lido Beach. Inorganic residues were detected in almost all of the tissue samples, although beryllium was below the level of detection in four out of seven samples. Concentrations of PAH tended to be below the level of detection in tissue samples, but the detection limit in tissue was approximately an order of magnitude greater than the detection limit in sediment and soil. The same was true of PCB. While total DDT residues were only detected in a tissue sample from Lido Beach, the highest sediment concentrations of DDT were found at Conscience Point and Morton. Only residues detected in at least one sample will be discussed hereafter. Appendix B has the raw numbers from which the figures in the

Figure 12. Composite tissue sample sites at Conscience Point National Wildlife Refuge

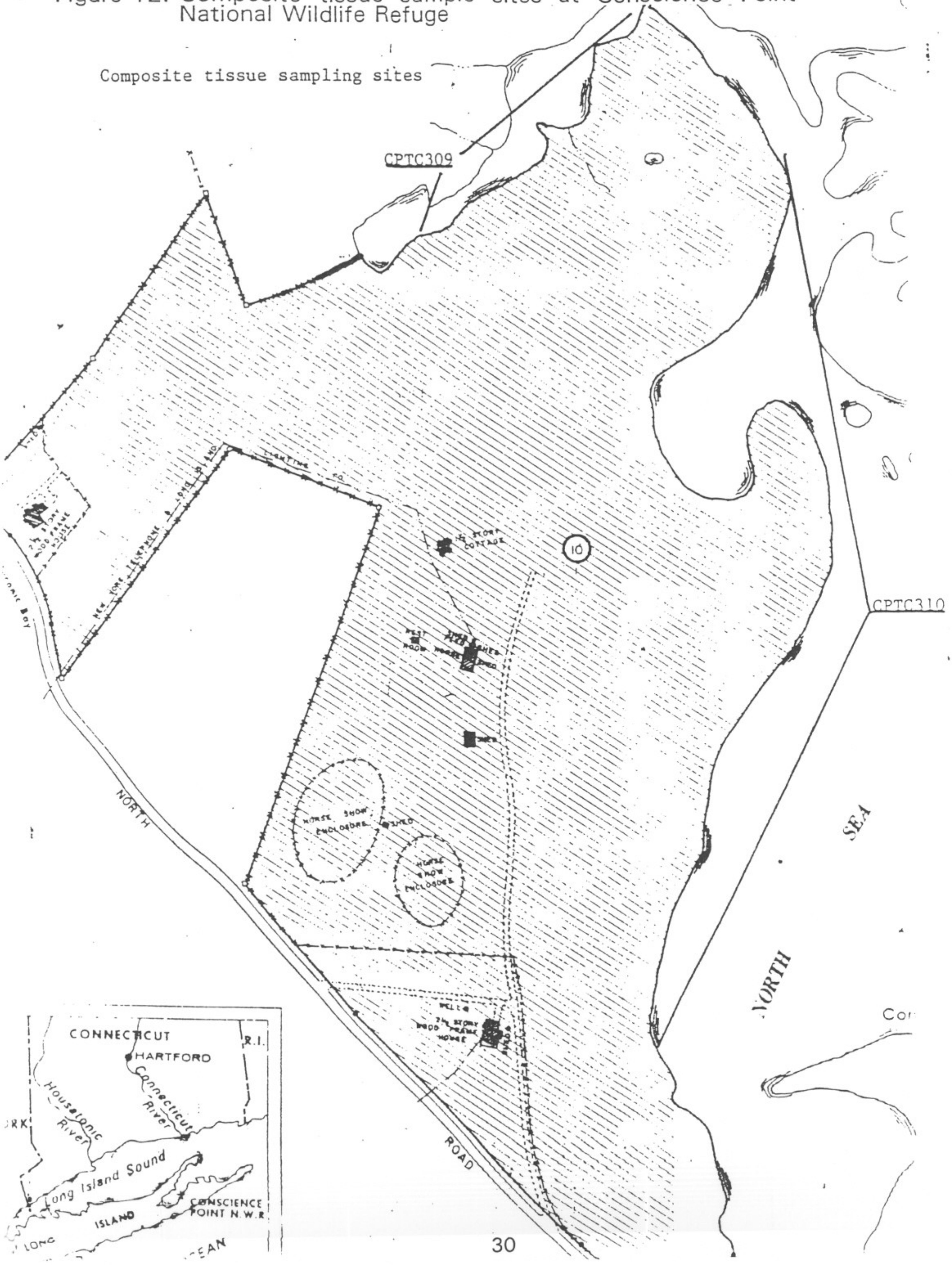
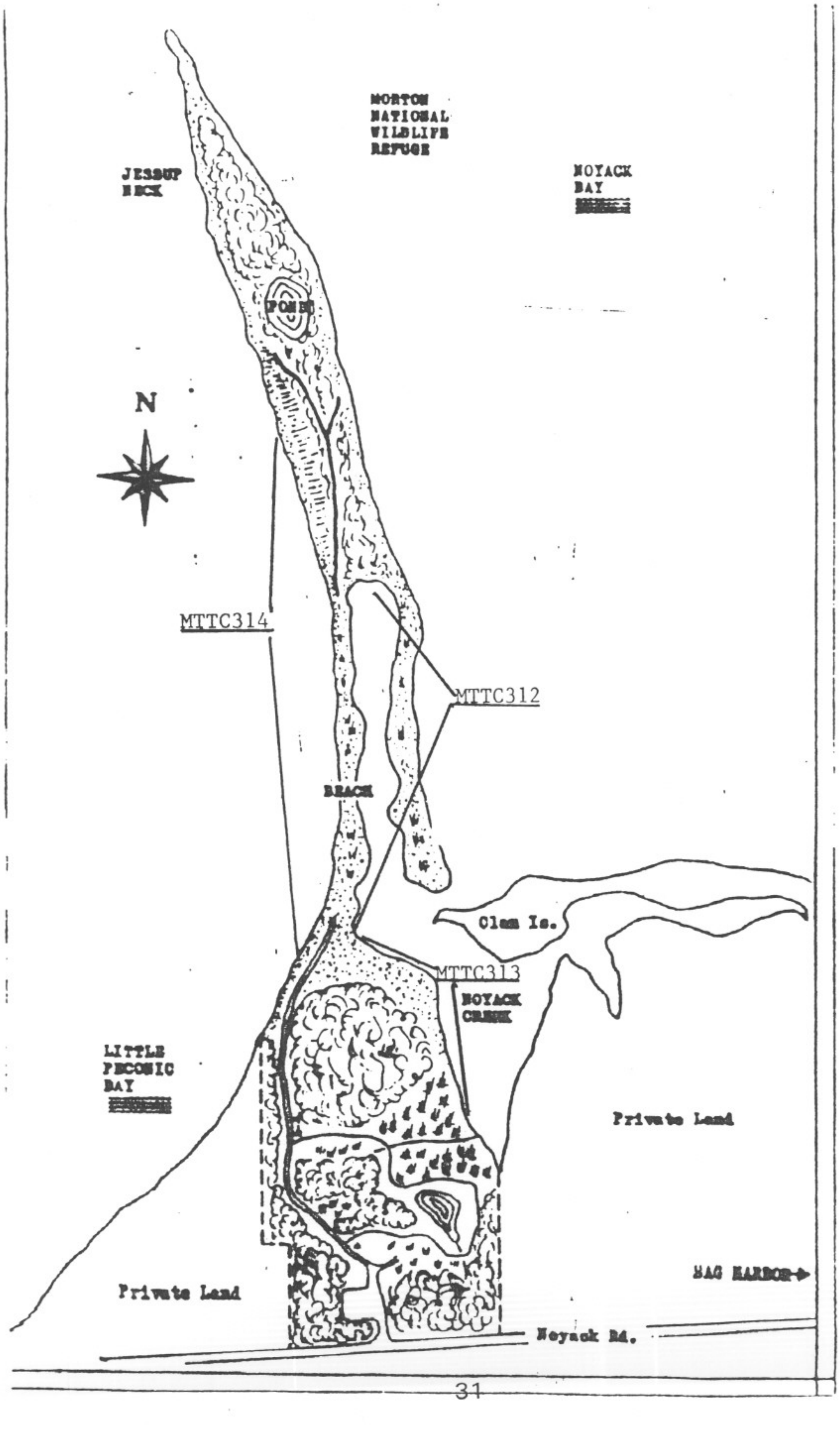


Figure 14. Composite tissue sample sites at Morton National Wildlife Refuge



following sections are derived. Table 2 provides a summary of the physical parameters for the soil and sediment samples.

CONSCIENÇE POINT NWR

Soil and Sediment Samples:
Of the sediment samples collected at Conscience Point NWR, sample 308B had the lowest concentrations for 16 of the 17 detected inorganic residues (Fig. 11). Sample 305B had the highest concentrations for 10 ofthe 17 inorganic residues. Sample 303B had the highest concentrations for 6 of the inorganic residues. Mercury and selenium were not detected in any sample. Boron was not detected in samples 301B, 302B, 307B, or 308B. Cadmium was not detected in samples 301B, 302B, 304B, 306B, and 308B. Beryllium was not detected in samples 301B, 302B, 306B, and 308B. Copper was not detected in samples 302B, and 308B. Molybdenum was only detected in 303B and 304B. Nickel was not detected in 301B, 302B, 306B or 308B. Lead was not detected in 308B. Strontium was not detected in 301B. Vanadium was not detected in 308B (Table 3).

Samples 303A and 307A were analyzed for PAH and aliphatic hydrocarbons (Table 11). Of the 45 PAH compounds measured, 26 were found in 303A and 31 plus an unknown mixture were found in 307A. 1,2,5,6-dibenzanthracene, 1,6,7-Trimethyl-naphthalene, C1-dibenzothiophenes, C2-dibenzothiophenes, and biphenyl were not detected in either sample. Of the 25 aliphatic hydrocarbons tested, 20 were found in sample 303A and 21 were found in sample 307A.

n-triacontane, n-dotriacontane, n-tertriacontane, and n-tritriacontane (the longest chain aliphatics analyzed, with more than 30 carbon atoms in a straight chain) were not detected in either sample.

Table 1. Contaminants analyzed and respective levels of detection for all samples collected in 1993

Analyte	Sediment Detection Limit (ppm Wet weight)	Tissue Detection Limit (ppm Wet Weight
PAH	0.001	0.002
Organochlorine Pesticides	0.001	0.002
PCB	0.001	0.002
Aliphatic Hydrocarbons	0.001	0.002
	Sediment Detection Limit (ppm Dry Weight)	Tissue Detection Limit (ppm Dry Weight)
Aluminum	100	5
Arsenic	0.5	0.5
Boron	5	0.5
Barium	3	0.5
Beryllium	0.2	0.2
Cadmium	0.2	0.2
Chromium	5	5
Copper	5	0.5
Iron	100	10
Mercury	0.1	0.1
Magnesium	100	10
Manganese	4	0.4
Molybdenum	5	0.5
Nickel	5	0.5
Lead	5	0.5
Selenium	0.5	0.5
Strontium	2	0.2
Vanadium	5	0.5
Zinc	5	1

Table 2. Total Organic Carbon and grain size distribution in soil and sediment samples collected from the Long Island National Wildlife Refuge Complex in 1993

Sample	TOC	% Sand	% Silt	% Clay
CPSC 301A	1.31	70.4	20.7	0.69
CPSC 302A	1.47	70.2	24.9	0.67
CPSC 303A	9.66	62.4	30.1	2.58
CPSC 304A	4.83	74.9	15.3	1.16
CPSC 305A	3.23	78.6	12.2	0.95
CPSC 306A	1.76	92.8	2.05	0.46
CPSC 307A	2.22	62.2	30	0.65
CPSC 308A	0.7	85.6	7.74	0.4
LBSC 301A	0.49	86.7	8.48	0.54
LBSC 302A	1.1	87	8.44	0.52
LBSC 303A	3.46	75.3	15.9	0.89
LBSC 304A	2.94	67.9	22.2	1.31
LBSC 305A	6.92	66	24.9	1.88
LBSC 306A	0.5	64.1	27.5	1.51
LBSC 307A	8.51	77.4	16.3	1.74
MTSC 301A	4.21	62.2	33.7	0.97
MTSC 302A	2.17	71.6	21.7	0.73
MTSC 303A	1.3	75.6	17.5	0.7
MTSC 304A	7.13	76.2	16.8	0.47
MTSC 305A	0.04	96.7	0.79	0.24
MTSC 306A	3.74	61	31.9	0.89
MTSC 307A	7.06	68.7	22.2	0.87
MTSC 308A	1.76	64.3	30.3	0.27
MTSC 309A	0.06	92.2	2.39	0.28

Table 2 (Continued)

Sample	TOC	% Sand	% Silt	% Clay
MTSC 310A	1.51	76.7	11.1	2.58
MTSC 311A	2.72	70.4	23.8	0.48
SVSC 301A	1.53	62.5	30	0.5
SVSC 302A	1.53	65.8	26.9	0.32
SVSC 303A	1.93	61.2	32.7	0.38
SVSC 304A	1.98	59.4	35.6	0.47

Table 3. Concentrations of metallic elements (ppm) found in sediment from Conscience Point National Wildlife Refuge in 1993

Analyte	CPSC 301B	CPSC 302B	CPSC 303B	CPSC 304B	CPSC 305B	CPSC 306B	CPSC 307B	CPSC 308B
Al	4189	6404	4186	4533	8924	2887	7601	602.2
As	1.94	1.59	2.43	3.06	3.47	2.57	2.36	0.81
B	<5	<5	45.02	38.65	22.79	14.71	<5	<5
Ba	12.07	15.4	8.08	8.20	20.35	7.12	16.51	<3
Be	<0.2	<0.2	1.94	<0.2	0.37	<0.2	0.41	<0.2
Cd	<0.2	<0.2	1.94*	<0.2	0.56	<0.2	0.41	<0.2
Cr	31.07*	40.19*	26.49*	30.63*	46.31*	30.7*	23.82	14.1
Cu	18.18*	<5	18.02*	11.36	33.09*	15.01	6.443	<5
Fe	3950	5502	5835	6946	14820	5732	4992	912.8
Hg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mg	389.5	626.4	4772	4687	5387	2353	1274	357.8
Mn	46.46	93.57	40.52	61.89	171.4	66.3	28.07	8.26
Mo	<5	<5	9.101	7.632	<5	<5	<5	<5
Ni	<5	<5	14.42	8.01	13.8	<5	6.71	<5
Pb	15.09	11.8	23.73	16.01	21.75	9.202	12.74	<5
Se	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sr	<2	2.957	41.94	33.42	73.32	122	7.23	2.135
V	7.932	10.51	18.21	20.87	21.95	10.66	13.06	<5
Zn	12.9	12.36	22.06	27.2	68.61	23.74	18.71	5.47

* - Exceeds NYSDEC lowest effect level

Table 11. Concentrations of PAHs and aliphatic hydrocarbons (ppb, dry weight) found in sediment and soil from the Long Island National Wildlife Refuge Complex in 1993

Analyte	CPSC 303A	CPSC 307A	LBSC 303A	MTSC 301A	MTSC 310A	SVSC 301A
1,2,5,6-dibenzanthracene			6.803			18.13
1,2-benzanthracene	14.89	5.334	45.49	8.870	13.63	63.87
1,6,7-trimethylnaphthalene			2.551		2.899	2.026
1-methylphenanthrene	3.640		4.677		6.669	2.453
2,6-dimethylnaphthalene	3.309	10.82	10.63	2.033	4.639	7.464
2-methylnaphthlene		2.438	6.378	1.848	2.559	
C1-fluoranthenes & pyrenes	19.52	8.229	50.60	12.75	58.01	
C1-phenanthrenes & anthracenes	15.88	20.73	36.14	8.686	28.04	
C1-chrysenes	17.21	6.705	32.53	18.30	38.92	
C1-dibenzothiophenes			4.039			2.453
C1-fluorenes		2.286	10.63	4.066		3.199
C1-naphthalenes	5.956	2.743	11.27	3.142	12.47	5.118
C2-phenanthrenes & anthracenes	19.52	21.18	32.31	12.75		27.19
C2-chrysenes	8.273	3.352	14.03	5.359		26.98
C2-dibenzothiophenes			6.165	2.403		2.986
C2-fluorenes		9.601	12.17	7.577		4.798
C2-naphthalenes		3.657	15.31	5.544		6.824

* - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for human health bioaccumulation

Table 11 (Continued)

Analyte	CPSC 303A	CPSC 307A	LBSC 303A	MTSC 301A	MTSC 310A	SVSC 301A
C3-phenanthrenes & anthracenes	9.596	14.63	19.35	6.838		22.18
C3-chrysenes				2.033		4.159
C3-dibenzothiophenes			4.039	1.848		4.372
C3-fluorenes		7.772	16.58	7.208		7.358
C3-naphthalenes		10.82	17.64	12.75		9.810
C4-phenanthrenes & anthracenes			7.653			13.65
C4-chrysenes			5.315	1.848		7.891
C4-naphthalenes			15.94			5.971
acenaphthalene			3.614		5.219	2.666
acenaphthene			7.866			3.626
anthracene	4.964	13.72	17.22		3.479	13.22
benzo(a)pyrene	16.87	6.096	53.36*	9.610	14.79*	102.3
benzo(b)fluoranthene	16.55	6.705	41.03*	10.72	12.18*	83.28
benzo(e)pyrene	15.55	5.943	34.44	8.871	9.858	71.44
benzo(g,h,i)perylene	8.273	5.639	33.38	7.023	9.858	65.58

* - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for human health bioaccumulation

Table 11 (Continued)

Analyte	CPSC 303A	CPSC 307A	LBSC 303A	MTSC 301A	MTSC 310A	SVSC 301A
benzo(k)fluroanthene	16.55	6.705	41.03*	10.72	12.18*	83.28
biphenyl			2.976		4.929	1.386
chrysene	23.16	8.686	53.36*	14.42	15.95*	120.1
fluoranthene	49.64	14.48	136.7	25.69	46.97	171.5
fluorene	3.971		9.353	3.142	3.189	3.626
indeno(1,2,3-cd) pyrene	8.604	5.029	29.97*	7.392	10.44	63.55
perylene	48.64	139.6	19.98	613.4	15.95	27.83
phenanthrene	25.15	6.705	51.45	12.01	16.24	68.14
phytane	69.82	27.43	27.64	55.81	9.858	3.834
pristane	19.85	23.62	9.353	33.64		4.692
pyrene	43.35	15.54	109.7	21.07	36.82	154.4
naphthalene	5.625	3.048	10.20	2.772	6.089	4.479
Unknown		18.90	12.97	3.881		5.758
PAH-Total	494.7	438.1	1093.9	966.0	401.8	1303.5
n-decane (C_{10})	44.34	15.39	29.34	58.40	65.53	17.70
n-undecane (C_{11})	30.77	13.72	12.12	57.66	11.02	11.20
n-dodecane (C_{12})	25.81	8.839	8.078	49.53	10.44	9.810
n-tridecane (C_{13})	33.09	5.181	6.590	12.38		3.092
n-tetradecane (C_{14})	7.611	5.639	5.740	14.23		4.052
n-pentadecane (C_{15})	41.03	6.858	43.58	157.5	44.36	5.438

* - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for human health bioaccumulation

Table 11 (Continued)

Analyte	CPSC 303A	CPSC 307A	LBSC 303A	MTSC 301A	MTSC 310A	SVSC 301A
n-hexadecane (C_{16})	23.83	5.639	19.56	16.63		3.306
n-heptadecane (C_{17})	820.0	25.6	607.6	237.8	121.2	8.211
n-octadecane (C_{18})	49.64	19.96	29.76	46.57	8.408	10.88
n-nonadecane (C_{19})	85.70	44.04	54.21	106.3	25.80	12.48
n-eicosane (C_{20})	36.07	40.54	24.23	74.66	10.43	24.95
n-heneicosane (C_{21})	154.2	96.46	107.4	208.6	27.54	68.56
n-docosane (C_{22})	103.6	73.45	64.63	189.6	19.43	113.5
n-tricosane (C_{23})	455.3	216.1	316.5	614.5	69.59	258.9
n-tetracosane (C_{24})	642.6	83.66	313.1	237.4	41.17	33.70
n-pentacosane (C_{25})	614.5	321.9	362.5	918.9	100.6	493.8
n-hexacosane (C_{26})	153.5	93.57	125.2	324.5	37.40	492.5
n-heptacosane (C_{27})	199.2	455.8	413.7	1140.5	173.1	656.5
n-octacosane (C_{28})	13.23	110.6	31.46	192.9	48.42	484.2
n-nonacosane (C_{29})		154.4	45.07	240.8	493.8	837.3
n-triacontane (C_{30})			37.84		34.21	368.1
n-hentriacontane (C_{31})	7.280		7.653	2.587	279.8	429.9
n-dotriacontane (C_{32})			5.527		17.11	70.80
n-tertriacontane (C_{33})						

* - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for human health bioaccumulation

Table 4. Concentrations of PCBs and organochlorines (ppb, dry weight) found in sediment from Conscience Point National Wildlife Refuge in 1993

Analyte	CPSC 301A	CPSC 302A	CPSC 303A	CPSC 304A	CPSC 305A	CPSC 306A	CPSC 307A	CPSC 308A
PCB 170	3.709		16.67					
PCB 172			5.146	6.126	6.610	6.991	2.819	2.970
PCB 189							3.011	
PCB 44			5.202					
PCB 45					10.67			
PCB 49			5.205		3.295	3.433		1.296
PCB - TOTAL			32.10*		20.57*			
Gamma-chlordane							16.98*	
Trans-nonachlor							15.66	
Dieldrin			6.310	7.515*			16.46*	
Endrin	2.978							
Mirex	1.639*							
o,p'-DDD	1.449						1074.6	
o,p'-DDE	15.76						93.77	
o,p'-DDT	147.8	1.704						
p,p'-DDD	18.35		45.76	26.69		16.88	4104.7	
p,p'-DDE	161.8	3.124	27.08	19.44		20.52	625.3	4.089
p,p'-DDT	234.9	3.646					34.52#	
DDT-Total	580.1	8.474*	72.84*	46.13*		37.40*	5932.9*+	4.089

* - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for human health bioacumulation

+ - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for wildlife bioacumulation

- On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for benthic aquatic life chronic toxicity

Samples from all locations were tested for PCB residues (Table 4). Residues of PCB 172 were found in all samples at concentrations ranging from 2-7 parts per billion (ppb). PCB 44 was found in sample 303A only. PCB 189 was found in sample 307A only. PCB 45 was found at 305A only. PCB 49 was detected in samples 301A, 303A, 305A, and 306A. PCB 84 was found in Sample 302A only. PCB 170 was found in 301A and 303A. Only samples 302A, 303A, and 305A had total PCB concentrations above the limit of detection.

Samples from all locations were tested for residues of organochlorine pesticides (Table 4). Sample 307A contained the greatest variety of residues, including gamma-chlordane, trans-nonachlor, dieldrin, o,p'-DDD, o,p'-DDE, p,p'-DDD, p,p'-DDE, and p,p'-DDT. The soil sample 301A also

had a broad spectrum of residues, including endrin, mirex, and all 6 tested DDT residues. Dieldrin was also found at 303A and 304A. p,p'-DDD and p,p'-DDE were the most commonly detected pesticide residues. p,p'-DDD was detected at 301A, 303A, 304A, 306A, and 307A. p,p'-DDE was found at all points except 305A.

Invertebrate Samples:
Two composite tissue samples, 309 and 310, were collected at Conscience Point NWR (Tables 12-15). Of the inorganic materials measured, beryllium was below the level of detection in both samples. All other elements were detected in both samples. Sample 309B had the lower concentrations for 13 of the 18 detected inorganic residues.
Sample 309A was analyzed for PAH and aliphatic hydrocarbons. Of the 45 PAH compounds measured, 10 plus an unknown mixture were found in 309A. 1-methylnaphthalene, 2-methylnaphthalene, C1-naphthalenes, C2-naphthalenes, C3-naphthalenes, C4-naphthalenes, acenaphthene, phenanthrene, pristane, and naphthalene were the identified compounds. Of the 25 aliphatic hydrocarbons tested, 22 were found in sample 309A. n-decane (10 carbon atoms), n-dotriacontane (32 carbon atoms), and n-tertriacontane (33 carbon atoms) were not detected.

Samples from both locations were tested for PCB residues. No PCB residues were found in sample 309A. Residues of PCB 153, PCB 187/182/159, PCB 41/64, and PCB 60/56 were found in 310A at concentrations ranging from 51-315 parts per billion (ppb). Sample 310A had total PCB concentrations of 546 ppb.

Samples from both locations were tested for residues of organochlorine pesticides. No pesticides were found in either sample.

Table 12. Concentrations of metallic elements (ppm) found in mussel and fish tissue from the Long Island National Wildlife Refuge Complex in 1993

Analyte	CPTC 309B	CPTC 310B	LBTC 308B	LBTC 309B	MTTC 312B	MTTC 313B	MTTC 314B+
Al	93.31	219.7	122.2	150.3	181.4	249.5	53.83
As	9.83*	8.72*	7.34*	7.96*	9.34*	8.44*	3.69*
B	37.3	37.09	28.05	32.93	27.11	32.88	5.19
Ba	1.291	1.81	0.655	1.037	1.338	2.394	1.75
Be	<0.1	<0.2	<0.1	0.304	0.104	0.130	<0.1
Cd	1.09*	1.679*	0.517*	0.9685*	1.063*	1.238*	0.1623
Cr	1.629*	3.403*	2.5*	1.955*	8.765*	3.01*	3.275*
Cu	12.32	16.33	14.72	16.52	10.99	15.58	5.527
Fe	295	470.3	393.1	475.1	494.9	646.3	95.20
Hg	0.100*	0.154*	0.203*	0.251*	0.205*	0.232*	0.146*
Mg	10240	9951	6307	8074	6707	8341	2994
Mn	16.22	12.88	5.674	10.21	13.51	34.19	14.69
Mo	0.680	1.462	0.522	1.445	1.188	1.952	<0.5
Ni	0.617	1.84	<0.5	2.314	1.65	2.382	0.8677
Pb	1.398	3.823	1.873	3.385	5.62	3.598	1.106
Se	2.2	2.57	1.8	2.06	2.35	2.95	2.62
Sr	53.26	103.2	39.15	46.62	41.7	93.13	157.1
V	1.093	2.162	0.993	1.606	2.964	3.228	<0.5
Zn	54.17	62.05	61.11	63.14	56.39	94.04	105.2

* - Exceeds predator protection level
+ - Composite fish tissue sample

Table 13. Concentrations of PAHs (ppb, dry weight) found in composite ribbed mussel tissue from the Long Island National Wildlife Refuge Complex in 1993

Analyte	CPTC 309A	LBTC 309A	MTTC 313A
1,2,5,6-dibenzanthracene			
1,2-benzanthracene			
1,6,7-trimethylnaphthalene		26.09	508.1
1-methylphenanthrene	503.9	589.8	
2,6-dimethylnaphthalene		45.37	371.7
2-methylnaphthlene	317.8	566.0	
C1-fluoranthenes & pyrenes		96.42	
C1-phenanthrenes & anthracenes		215.5	
C1-chrysenes			
C1-dibenzothiophenes			
C1-fluorenes			
C1-naphthalenes	823.0	1155.9	879.8
C2-phenanthrenes & anthracenes			
C2-chrysenes			
C2-dibenzothiophenes			
C2-fluorenes			
C2-naphthalenes	171.6	265.4	352.2
C3-phenanthrenes & anthracenes			
C3-chrysenes			
C3-dibenzothiophenes			
C3-fluorenes			

Table 13 (Continued)

Analyte	CPTC 309A	LBTC 309A	MTTC 313A
C3-naphthalenes	195.8	262.0	229.3
C4-phenanthrenes & anthracenes			
C4-chrysenes			
C4-naphthalenes	160.7	242.7	
acenaphthalene		68.06	
anthracene		34.03	
benzo(a)pyrene			
benzo(b)fluoranthene			
benzo(e)pyrene			
benzo(g,h,i)perylene			
benzo(k)fluroanthene			
biphenyl			
chrysene		26.09	
fluoranthene		172.4	
fluorene		89.61	
indeno(1,2,3-cd) pyrene			
perylene			
phenanthrene	71.30	458.3	70.44
phytane		102.1	
pristane	126.9	105.5	112.4
pyrene		213.2	
naphthalene	835.0	1510.9	840.8
Unknown	254.4	324.9	375.6
PAH-Total	3488.1	6897.1	3740.34

Table 14. Concentrations of aliphatic hydrocarbons (ppb, dry weight) found in composite ribbed mussel tissue from the Long Island National Wildlife Refuge Complex in 1993

Analyte	CPTC 309A	LBTC 309A	MTTC 313A
n-decane (C_{10})			
n-undecane (C_{11})	58.01	37.43	
n-dodecane (C_{12})	1142.0	1237.5	1435.9
n-tridecane (C_{13})	100.3	29.49	62.95
n-tetradecane (C_{14})	172.8	78.27	124.4
n-pentadecane (C_{15})	481.1	258.6	759.9
n-hexadecane (C_{16})	414.5	230.3	239.8
n-heptadecane (C_{17})	584.9	554.7	292.3
n-octadecane (C_{18})	88.22	65.79	89.93
n-nonadecane (C_{19})	85.80	93.01	73.44
n-eicosane (C_{20})	74.92		46.46
n-heneicosane (C_{21})	51.12		154.4
n-docosane (C_{22})	72.51	47.64	62.95
n-tricosane (C_{23})	314.2	83.94	80.94
n-tetracosane (C_{24})	102.7	60.11	89.93
n-pentacosane (C_{25})	163.1	226.9	112.4
n-hexacosane (C_{26})	43.50	54.45	50.96
n-heptacosane (C_{27})	79.76	123.6	95.92
n-octacosane (C_{28})	48.34	88.48	76.44
n-nonacosane (C_{29})	298.5	410.6	307.3
n-triacontane (C_{30})	79.75	145.2	139.4
n-hentriacontane (C_{31})	113.6	268.8	115.4
n-dotriacontane (C_{32})			154.4
n-tertriacontane (C_{33})			71.94
Aliphatics-Total	4155.1	4095.1	4637.5

Table 15. Concentrations of PCBs and organochlorines (ppb, dry weight) found incomposite ribbed mussel and fish tissue from the Long Island National Wildlife Refuge Complex in 1993

Analyte	CPTC 309A	CPTC 310A	LBTC 308A	LBTC 309A	MTTC 312A	MTTC 313A	MTTC 314A*
PCB 138							23.22
PCB 153		66.38					57.44
PCB 170							64.70
PCB 172			55.58		65.55		19.18
PCB 187/182/159		112.5					17.06
PCB 41/64		51.71			10.67		
PCB 44				27.54			
PCB 47/48							14.59
PCB 49			29.57				26.94
PCB 52							16.38
PCB 60/56		315.4					
PCB - TOTAL		546.0+	196.8				239.3x
Alpha-chlordane			23.57				
Gamma-chlordane			41.78				
cis-nonachlor			20.85				
trans-nonachlor							15.92
o,p'-DDT			31.16				
p,p'-DDD			197.6				
p,p'-DDE			111.1				130.7
p,p'-DDT			53.25				
DDT-Total			393.1				130.7

* - Composite fish tissue sample

+ - Exceeds aquatic predator protection level

x - Exceeds predator protection level for mink

MORTON NWR

Soil and Sediment Samples:
Of the sediment samples collected at Morton NWR, sample 309B had the lowest concentrations for 15 of the 18 detected inorganic residues (Table 5). Sample 310B had the highest concentrations for 7 of the 17 inorganic residues. Sample 304B had the highest concentrations for 5 of the inorganic residues, and Sample 311B had the highest concentrations of 4 elements. Mercury was not detected in any sample. Boron was only detected in samples 303B, 304B, and 310B. Barium was not detected in 305A or 309B. Beryllium was not detected in sample 309B. Cadmium was not detected in samples 303B, 304B, 308B, 309B, and 311B. Chromium was not detected in 305A, 307B, and 308B. Copper was not detected in 302B, 305A, 307A, 308A, and 309A. Magnesium was not detected in 305A. Molybdenum was only detected in 304B. Nickel was not detected in 302B, 303B, 307B, 308B, 309B, and 311B. Lead was not detected in 303B, 305A, or 309B. Selenium was only detected in 301B and 307B. Strontium was not detected in 309B. Vanadium and zinc were not detected in 305A or 309B.

Samples 301A and 310A were analyzed for PAH and aliphatic hydrocarbons (Table 11). Of the 45 PAH compounds measured, 34 plus and unknown mixture were found in 301A and 27 were found in 310A. 1,2,5,6-dibenzanthracene, C1-dibenzothiophenes, C4-Phenanthrenes and Anthracenes, and C4-naphthalenes were not detected in either sample. Of the 25 aliphatic hydrocarbons tested, 21 were found in sample 301A and 21 were found in sample 310A. n-tertriacontane (33 carbon atoms) was not detected in either sample.

Samples from all locations were tested for PCB residues (Table 6). Residues of PCB 172 were found 302A, 306A, and 307A at concentrations ranging from 3-7 parts per billion (ppb). PCB 170 was found in sample 310A only. PCB 177 was found in 309A only. PCB 183 was found in sample 306A only. PCB 191 was found in 306A and 307A. PCB 200 was found in 306A only. PCB 46 was found in sample 304A only. Only samples 306A, 307A, 309A, and 311A had total PCB concentrations above the limit of detection.

Samples from all locations were tested for residues of organochlorine pesticides (Table 6). Sample 304A contained the greatest variety of residues, including gamma-chlordane, o,p'-DDD, o,p'-DDE, p,p'-DDD, p,p'-DDE, and p,p'-DDT. The soil sample 306A had all six tested DDT residues. p,p'-DDD and p,p'-DDE were the most commonly detected pesticide residues. Both were detected at 301A, 302A, 304A, 306A, and 307A.

Table 5. Concentrations of metallic elements (ppm) found in sediment from Morton National Wildlife Refuge in 1993

Analyte	MTSC 301B	MTSC 302B	MTSC 303B	MTSC 304B	MTSC 305A	MTSC 306B
Al	5398	2555	2159	3340	134.3	3172
As	1.21	0.65	0.94	1.28	<0.5	0.55
B	<5	<5	5.621	41.59	<5	<5
Ba	48.41	20.21	3.829	12.41	<3	22.06
Be	1.227	0.41	<0.2	0.256	1.381	1.598
Cd	0.913*	0.338	<0.2	<0.2	1.50*	1.62*
Cr	22.57	16.69	8.14	16.55	<5	9.08
Cu	12.07	<5	5.69	13.12	<5	5.75
Fe	5235	2490	2497	3013	181.6	1474
Hg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mg	747.2	303.6	1539	3444	<100	345.1
Mn	91.94	28.51	25.11	35.61	<4	15.19
Mo	<5	<5	<5	7.566	<5	<5
Ni	8.248	<5	<5	16.55	7.186	8.393
Pb	19.76	10.46	<5	33.31	<5	21.81
Se	0.58	<0.5	<0.5	<0.5	<0.5	<0.5
Sr	10.92	5.13	10.5	78.75	11.43	6.90
V	13.27	5.537	7.239	10.35	<5	7.552
Zn	32.15	35.35	7.693	40.78	<5	5.174

* - Exceeds NYSDEC lowest effect level

Table 5 (Continued)

Analyte	MTSC 307B	MTSC 308B	MTSC 309B	MTSC 310B	MTSC 311B
Al	3606	4819	172	1206	8094
As	1.31	1.55	<0.5	1.66	1.80
B	<5	<5	<5	20.96	<5
Ba	18.75	25.15	<3	6.053	22.46
Be	0.72	0.27	<0.2	1.75	0.29
Cd	0.664*	<0.2	<0.2	1.684*	<0.2
Cr	5.87	<5	<5	29.55*	9.92
Cu	<5	<5	<5	16.96*	6.16
Fe	3030	4375	123.7	1931	6662
Hg	<0.1	<0.1	<0.1	<0.1	<0.1
Mg	1119	464.1	158.6	1235	794.8
Mn	68.94	144.5	<4	26.25	262.3
Mo	<5	<5	<5	<5	<5
Ni	<5	<5	<5	11.76	<5
Pb	24.72	8.14	<5	9.81	29.1
Se	0.61	<0.5	<0.5	<0.5	<0.5
Sr	19.89	3.41	<2	95.15	6.83
V	8.29	8.40	<5	5.64	14.24
Zn	8.78	6.95	<5	16.08	17.76

* - Exceeds NYSDEC lowest effect level

Table 6. Concentrations of PCBs and organochlorines (ppb, dry weight) found in sediment from Morton National Wildlife Refuge in 1993

Analyte	MTSC 301A	MTSC 302A	MTSC 303A	MTSC 304A	MTSC 305A	MTSC 306A
PCB 172		3.354				4.949
PCB 177						
PCB 183						5.485
PCB 191						12.35
PCB 200						7.853
PCB 46				7.497		
PCB-Total						30.58*
gamma-chlordane				112.9$^{*+\#x}$	<5	5.75
o,p'-DDD		1.617		490.0		347.5
o,p'-DDE				49.67		43.65
o,p'-DDT						241.9
p,p'-DDD	27.53	50.47		4076.4		1522.3
p,p'-DDE	11.64	19.24		296.6		967.5
p,p'-DDT				1410.1		3131.3
DDT-Total	39.17*	71.33^{*+}		6322.77$^{*+\#}$		6254.2$^{*+\#}$

* - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for human health bioacumulation
+ - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for wildlife bioacumulation
# - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for benthic aquatic life chronic toxicity
x - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for benthic aquatic life acute toxicity

Table 6 (Continued)

Analyte	MTSC 307A	MTSC 308A	MTSC 309A	MTSC 310A	MTSC 311A
PCB 172	6.551				
PCB 177					21.74
PCB 183					
PCB 191	6.152				
PCB 200					
PCB 46					
PCB-Total	12.64*				21.74
gamma-chlordane					
o,p'-DDD	2.602				
o,p'-DDE					
o,p'-DDT					
p,p'-DDD	38.76				
p,p'-DDE	40.21				10.30
p,p'-DDT	13.22				
DDT-Total	94.79*+				10.30

* - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for human health bioacumulation
+ - On a μg/g of organic carbon basis, exceeds NYSDEC guidelines for wildlife bioacumulation

Invertebrate Samples:
Two composite tissue samples, 312 and 313, were collected at Morton NWR (Tables 12-15). All of the target elements were detected in both samples. Sample 312B had the lower concentrations for 15 of the 19 inorganic residues.

Sample 313A was analyzed for PAH and aliphatic hydrocarbons. Of the 45 PAH compounds measured, 8 plus an unknown mixture were found in 309A. 1,6,7-trimethyl-naphthalene, 2,6-dimethylnaphthalene, C1-naphthalenes, C2-naphthalenes, C3-naphthalenes, phenanthrene, pristane, and naphthalene were the identified compounds. Of the 25 aliphatic hydrocarbons tested, 23 were found in sample 309A. n-decane (10 carbon atoms) and n-undecane (11 carbon atoms) were not detected.

Samples from both locations were tested for PCB residues. Residues of PCB 172 were found in 312A at a concentration of 65 parts per billion (ppb). Residues of PCB 44 at a concentration of 5 ppb were found in sample 313A. Neither sample had a total PCB concentrations above the level of detection (116-128 ppb).

Samples from both locations were tested for residues of organochlorine pesticides. No pesticides were found in either sample.

LIDO BEACH WMA

Soil and Sediment Samples:
Of the sediment samples collected at Lido Beach WMA, sample 301B had the lowest concentrations for 12 of the 17 detected inorganic residues (Table 7). Sample 310B had the highest concentrations for 7 of the 17 inorganic residues. Samples 305B and 307B each had the highest concentrations for 6 of the inorganic residues, and Sample 304B had the highest concentrations of 4 elements. Selenium was not detected in any sample. Beryllium was not detected in sample 302B. Cadmium was not detected in samples 301B, 303B, 304B, and 307B. Copper was not detected in 301B. Molybdenum was not detected in 301B, 302B, 304B, and 306B.

Sample 303A was analyzed for PAH and aliphatic hydrocarbons (Table 11). Of the 45 PAH compounds measured, 44 plus an unknown mixture were found in 303A. Only C3-chrysenes were not detected in this sample. Of the 25 aliphatic hydrocarbons tested, 24 were found in the sample. n-tertriacontane (33 carbon atoms) was not detected in the sample.

Samples from all locations were tested for PCB residues (Table 8). Residues of PCB 172 were found in all samples at concentrations ranging from 2-17 parts per billion (ppb). PCB 110/77 was found in 302A only. PCB 138 was found in 301A only. PCB 187/182/159 was found in sample 303A only. PCB 29 was found in sample 305A only. PCB 45 was found at 305A only. PCB 49 was detected in all samples at concentrations ranging from 1-7 ppb. Only samples 302A and 307A had total PCB concentrations above the limit of detection.

Table 7. Concentrations of metallic elements (ppm) found in sediment from Lido Beach Wildlife Management Area in 1993

Analyte	LBSC 301B	LSBC 302B	LBSC 303B	LBSC 304B	LBSC 305B	LBSC 306B	LBSC 307B
Al	1931	3489	6286	7209	11640	3110	11300
As	3.93	3.7	7.59*	7.62*	9.84*	3.17	5.57
B	5.22	7.26	31.84	29.39	67.96	14.2	81.58
Ba	8.59	16.82	19.59	15.8	25.42	9.13	24.94
Be	0.65	<0.2	0.27	1.10	0.68	0.21	0.47
Cd	0.53	<0.2	<0.2	0.98*	0.37	0.36	<0.2
Cr	11.05	26.97*	27.75*	26.77*	33.85*	16.27	31.78*
Cu	<5	6.57	17.59*	15.48*	11.61	10.28	17.99*
Fe	5374	4728	10530	14660	19920	6803	14350
Hg	<0.1	0.11	0.10	0.18	<0.1	<0.1	<0.1
Mg	1217	1381	4509	4778	7443	2358	8870
Mn	33.85	57.58	81.02	95.25	111.4	56.81	114.8
Mo	<5	<5	9.55	<5	13.45	<5	11.39
Ni	5.91	8.948	24.58*	17.86*	18.99*	7.173	24.42*
Pb	17.01	23.19	51.01*	40.54*	18.79	12.3	18.46
Se	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Sr	11.72	17.85	32.91	29	43.41	21.51	50.88
V	11.47	11.8	30.56	29.31	46.31	11.84	47.14
Zn	25.08	22.6	43.3	47.99	45.5	29.77	40.26

* - Exceeds NYSDEC lowest effect level

Table 8. Concentrations of PCBs and organochlorines (ppb, dry weight) found in sediment from Lido Beach Wildlife Management Area in 1993

Analyte	LBSC 301A	LSBC 302A	LBSC 303A	LBSC 304A	LBSC 305A	LBSC 306A	LBSC 307A
PCB 110/77		6.150					
PCB 138	1.386						
PCB 172	2.830	3.001	2.387	6.278	8.344	3.448	17.18
PCB 187/182/159			5.408				
PCB 29						2.595	
PCB 49	1.254			2.802	4.261	1.536	7.699
PCB-Total	7.253*					9.164*	
alpha-chlordane		7.531					
gamma-chlordane		6.700					
cis-nonachlor		4.489					
trans-nonachlor		7.635					
oxychlordane		1.658					
heptachlor epoxide		1.303					
dieldrin		3.419				2.910*	
o,p'-DDT		1.547					
p,p'-DDD	17.44	14.09					
p,p'-DDE	47.95	12.52		5.239		2.682	
p,p'-DDT	4.018	4.958					
DDT-Total	69.41*	33.12		5.239		2.682	

* - On a $\mu g/g$ of organic carbon basis, exceeds NYSDEC guidelines for human health bioaccumulation

Samples from all locations were tested for residues of organochlorine pesticides (Table 8). The soil sample 302A contained the greatest variety of residues, including alpha- and gamma-chlordane, oxychlordane, cis- and trans-nonachlor, heptachlor epoxide, dieldrin, o,p'-DDT, p,p'-DDD, p,p'-DDE, and p,p'-DDT. Dieldrin was also found at 306A. p,p'-DDE was the most commonly detected pesticide residues. It was found at 301A, 302A, 304A, and 306A.

Invertebrate Samples:
Two composite tissue samples, 308 and 309, were collected at Lido Beach WMA (Tables 12-15). All of the target elements were detected in both samples, except for beryllium and nickel which were only found in sample 309B. Sample 312B had the lower concentrations for 18 of the 19 inorganic residues.

Sample 309A was analyzed for PAH and aliphatic hydrocarbons. Of the 45 PAH compounds measured, 22 plus an unknown mixture were found in 309A. Of the 25 aliphatic hydrocarbons tested, 20 were found in sample 309A. n-decane (10 carbon atoms), n-dotriacontane (32 carbon atoms), n-eicosane (20 carbon atoms), n-heneicosane (21 carbon atoms), and n-tertriacontane (33 carbon atoms) were not detected.

Samples from both locations were tested for PCB residues. No PCB residues were found in sample 309A. Residues of PCB 172, PCB 44, and PCB 49 were found in sample 308A. The total PCB concentration in 308A was 197 ppb.

Samples from both locations were tested for residues of organochlorine pesticides. No pesticides were found in sample 309A. Residues of alpha- and gamma-chlordane, cis-nonachlor, o,p'-DDT, p,p'-DDD, p,p'-DDE, and p,p'-DDT were found in sample 308A.

SAYVILLE UNIT

Soil Samples:
Of the sediment samples collected at the Sayville Unit of the Long Island National Wildlife Refuge Complex, sample 302B had the lowest concentrations for 10 of the 16 detected inorganic residues (Figure 16 and Table 9). Sample 301B had the highest concentrations for 8 of the 17 inorganic residues. Samples 303B had the highest concentrations for 4 of the inorganic residues, and Sample 302B had the highest concentrations of 3 elements. Boron, molybdenum, and selenium were not detected in any sample. Copper was only detected in 301B. Selenium was not detected in 302B. Strontium was not detected in 304B/C.

Table 9. Concentrations of metallic elements (ppm) found in soil from the Sayville Unit in 1993

Analyte	SVSC 301B	SVSC 302B	SVSC 303B	SVSC 304B	SVSC 304C
Al	11140	7728	11720	10150	10150
As	4.28	2.62	4.07	3.42	3.42
B	<5	<5	<5	<5	<5
Ba	17.17	13.31	18.18	15.98	15.98
Be	0.34	1.79	1.10	0.809	0.809
Cd	0.244	1.438	0.831	0.451	0.451
Cr	30.21	16.35	19.44	16.67	16.67
Cu	16.16	<5	<5	<5	<5
Fe	11990	8276	10510	10730	10730
Hg	<0.1	<0.1	<0.1	<0.1	<0.1
Mg	820.9	483.4	762.4	668	668
Mn	56.35	30.05	43.6	33	33
Mo	<5	<5	<5	<5	<5
Ni	8.687	11.96	10.05	7.76	7.76
Pb	16.85	20.56	21.02	19.26	19.26
Se	0.53	<0.5	0.71	0.57	0.57
Sr	3.42	2.819	4.722	<2	<2
V	30.66	15.49	23.55	17.78	17.78
Zn	43.58	7.954	11.43	8.845	8.845

* - Exceeds NYSDEC lowest biological effect level

Table 10. Concentrations of PCBs and organochlorines (ppb, dry weight) found in soil from the Sayville Unit in 1993

Analyte	SVSC 301A	SVSC 302A	SVSC 303A	SVSC 304A
PCB 170		8.277		
p,p'-DDE	6.135		10.00	
p,p'-DDT		12.67		13.30
DDT-Total	6.135	12.67	10.00	13.30

Sample 301A was analyzed for PAH and aliphatic hydrocarbons (Table 11). Of the 45 PAH compounds measured, 41 plus an unknown mixture were found in 303A. 2,6-dimethylnaphthalene, C1-fluorenes and pyrenes, C1-phenanthrenes and anthracenes, and C1-chrysenes were not detected in this sample. Of the 25 aliphatic hydrocarbons tested, 24 were found in the sample. n-tertriacontane (33 carbon atoms) was not detected in the sample.

Samples from all locations were tested for PCB residues (Table 10). Only sample 301A contained measurable PCB residues, with residues of PCB 170 and total PCB concentrations of 8 parts per billion (ppb). Samples from all locations were tested for residues of organochlorine pesticides (Table 10). The samples 301A contained p,p'-DDE, while samples 302A and 304A contained p,p'-DDT. No other organochlorine pesticide residues were detected in these samples.

No invertebrate samples were taken for this inland site.

Fish Tissue Collected at Morton NWR

The composite fish tissue sample, 314, taken at Morton NWR was analyzed for the same elements as the invertebrate tissue (Tables 12-15). Beryllium, molybdenum, and vanadium were not detected in the sample.

Sample 314A was not analyzed for PAH and aliphatic hydrocarbons. However, the samples was tested for PCB residues. Residues of PCB 138, 172, and 187/182/159 were found in sample 314A, but the total PCB concentration in 314A was below the limit of detection.

The sample was tested for residues of organochlorine pesticides. Residues of trans-nonachlor and p,p'-DDE were found in sample 314A.

Microtox® Testing of Elutriate and Sediment

The Microtox® assay is a bacterial luminescence bioassay developed by Beckman, Inc. in 1977. The assay measures light output from a bioluminescent marine bacterium (*Photobacterium phosphoreum*); reduced light output implies contaminant poisoning. Results are determined by comparison of the light output of an exposed sample to a control sample.

Conscience Point NWR:
Eleven samples were taken from Conscience Point NWR, nine estuarine and two freshwater. Elutriate, rather than sediment, was the test material. Four of the estuarine samples did not demonstrate measurable toxicity. Of the remaining seven samples, five had EC_{50} values of less than 10%, meaning that a test solution containing less than 10% elutriate reduced the bacterial light output by 50% (Shaw 1993).

Lido Beach WMA:
Eight estuarine elutriate samples were tested from the WMA. Five of the eight samples did not demonstrate any measurable toxicity. The greatest toxicity occurred in sample LBMTX06, with a 5 minute EC_{50} of 1.47%. In comparison, sample LBMTX08 had a 5 minute EC_{50} of 33.85% (Shaw 1993).

Three sediment samples from Lido Beach WMA were tested. The sediment samples appeared to be more toxic than the elutriate samples, with 5 minute EC_{50} values ranging from 1.49-9.73% (Shaw 1993).

Morton NWR:
Thirteen elutriate samples were tested at Morton NWR. Of the seven freshwater samples, only two exhibited measurable toxicity. The lowest concentration producing an EC_{50} among these samples was 14.82% (Shaw 1993).

Two marine and four estuarine elutriate samples were tested at Morton NWR. None of these exhibited measurable toxicity (Shaw 1993).

DISCUSSION

Various concern levels will be used since there are no standard criteria for evaluating sediment, soil, and tissue contamination. These concern levels will include the apparent effects threshold (AET) for contaminants in sediment from Puget Sound (Barrick et al. 1988), National Oceanic and Atmospheric Administration's (NOAA) biological effect levels (Long and Morgan 1990), New York State Department of Environmental Conservation's (NYSDEC) sediment guidelines for the Division of Fish and Wildlife (NYSDEC 1993), the International Joint Commission's (IJC) suggested background sediment concentrations for the Great Lakes (Ingersoll and Nelson 1989), inorganic compound concentrations typically found in Long Island soil (Cappelli, pers. comm.), elemental concentrations in surficial materials (Shacklette et al. 1971), and various predator protection levels.

Conscience Point NWR

Sediment collected from Conscience Point NWR in 1993 had levels of arsenic, copper, cadmium, and chromium exceeding at least one of the concern levels reviewed. No PAH concern levels were exceeded in any of the sediment samples from Conscience Point NWR in 1993. Total PCB concentrations exceeded the NYSDEC sediment guidelines level of concern for human bioaccumulation at some of the sampling points at Conscience Point. Among the organochlorine insecticides, both chlordane and dieldrin were detected at concentrations exceeding the NYSDEC sediment guidelines level of concern for human bioaccumulation at scattered locations. However, DDT residues turned up at virtually all locations and in one instance reached concentrations in excess of the NYSDEC sediment guidelines level of concern for chronic toxicity to benthic aquatic life as well as the level of concern for wildlife bioaccumulation. Samples CPSC 301 and 302 were soil samples; no levels of concern have been established for upland soils.

Arsenic is listed by the U.S. Environmental Protection Agency (USEPA) as one of 129 priority pollutants (Keith and Telliard 1979). It is a nonmetallic element which has long been a concern because small amounts are toxic to humans (Hem 1985). Arsenic enters rivers from air pollution (fossil fuel combustion) and soil erosion as well as from pesticides and industrial sources. Significant amounts of arsenic are known to leach from municipal landfills (Health and Environment Network 1987). Arsenic is produced as a by-product of zinc, copper, and lead smelters, and possibly also produced through the large-scale burning of coal (Green 1988). Arsenic is used in a wide range of alloys, medicines, and electronic devices (National Library of Medicine 1988). The potential for bioaccumulation and bioconcentration is high to very high for mollusks, crustacea, lower animals, and higher plants (Jenkins 1981). All the samples except CPSC 308B were above the Great Lakes background levels of 1.1 μg/g (Ingersoll and Nelson 1989). However, the highest concentration of arsenic observed in any sample from Conscience Point NWR was 3.47 ppm, which is below the NYSDEC lowest observed effect level of 6.0 ppm.

Copper is listed by the USEPA as one of 129 priority pollutants (Keith and Telliard 1979). Copper is widely distributed in nature in the elemental state, in sulfides, arsenites, chlorides, and carbonates (National Library of Medicine 1988). Copper was the first metal used by man and is second only to iron in its utility through the ages. There are more than 1,000 alloys which incorporate copper. Copper is one of the most common contaminants associated with urban runoff, and specific sources include soil erosion, corrosion of pipes and tubes, industrial discharges, and sewage outfalls (USEPA 1980a). Minute amounts of copper are needed in the diet of humans, plants, and animals for enzyme production (Leland and Kuwabara 1985). Ingestion of copper in excess of dietary requirements leads to accumulation in tissues, particularly the liver and kidneys, which can cause copper toxicosis and cell damage (Leland and Kuwabara 1985). The potential for bioaccumulation of copper is high to very high for the following biota: mammals, birds, fish, mosses, lichens, algae, mollusks, crustacea, lower animals, and higher plants (Jenkins 1981). The concentrations of copper found in samples CPSC 303B and 305B, 18.18, 18.02, and 33.09 μg/g, respectively, were greater than the NYSDEC 1993 guideline of 16 μg/g. The concentration of copper in sample 305B was greater than the level considered by the IJC as the Great Lakes background (21.1 μg/g) (Ingersoll and Nelson 1989).

Chromium is a metallic element which is listed by the USEPA as one of 129 priority pollutants (Keith and Telliard 1979). Chromium does not occur free in nature; in bound form it makes up 0.1-0.3 parts per million on the Earth's crust (Grolier Electronic Publishing 1988). Although some salts of it are carcinogenic, and specific chromium compounds are quite toxic, the element itself has moderate to low toxicity (Jenkins 1981). Known sources of chromium include metal platers and a wide variety of chemical, photography, metal plating, scrap metal, machine shop, power plant, and industrial facilities (Eisler 1986, Rompala et al. 1984). Chromium is also present in the leachate of some municipal landfills (Lu et al. 1982). The potential for accumulation is considered high to very high for mosses, lichens, algae, mollusks, crustacea, lower animals, and higher plants (Jenkins 1981). The concentration of chromium in samples CPSC 303B-306B were greater than the NYSDEC guideline of 26 μg/g (NYSDEC 1993). Sample 305B had concentrations of chromium that exceeded the Great Lakes background level as determined by the IJC (37.1 μg/g) (Ingersoll and Nelson 1989).

Cadmium is a relatively rare, soft, silver-white, transition metal which is listed by the USEPA as one of 129 priority pollutants (Keith and Telliard 1979). All cadmium compounds are potentially harmful or toxic (Jenkins 1981). Cadmium is very toxic to a variety of species of fish and wildlife. It causes behavior, growth, and physiological problems in aquatic life at sublethal concentrations (Rompala et al. 1984). Cadmium tends to bioaccumulate in fish (Rompala et al. 1984), clams (Schmitt et al. 1987, Munawar et al. 1984), and algae (Munawar et al. 1984), especially in species living in close proximity to sediments contaminated by cadmium (Munawar et al. 1984). It is a suspected carcinogen (Friberg et al. 1979, Ames et al. 1987) and had been shown to cause birth defects in mammals (Friberg et al. 1979). Mammals and birds consuming cadmium contaminated food experienced lowered sperm counts, kidney damage, increase mortality of young, elevated blood sugar, and anemia (Rompala et al. 1984). About 75% of all cadmium produced is used for cadmium plating of easily corroded metals such as iron and steel. Because of its low melting point, 21.09°C, it is used in special alloys such as aluminum solder, and related alloys that are used for sprinkler installations and other fire-protection systems (Grolier Electronic Publishing 1988). Other sources of cadmium include: smelters, incinerators, oil furnaces, coal combustion, metal platers, scrap yards, batteries, television tubes, solar cells, fungicides, and various industrial discharges (Rompala et al. 1984). Significant amounts of cadmium can also be found in sewage sludge (Friberg et al. 1979, USEPA 1983) and in leachate from municipal landfills (Health and Environment Network 1987, Lu et al. 1982). The potential for bioaccumulation or bioconcentration is high for the following biota: mammals, birds, fish, mosses, lichens, algae, mollusks, crustacea, lower animals, and higher plants (Jenkins 1981). The NYSDEC guideline for cadmium and the suggested Great Lakes background sediment concentrations of cadmium (0.6 μg/g) was exceeded by the level in sample CPSC 303B (1.944 μg/g) (Ingersoll and Nelson 1989, NYSDEC 1993).

Concentrations of total PCB in samples 303A and 305A from Conscience Point were several orders of magnitude greater than the NYSDEC sediment guidelines level of concern for human health bioaccumulation. Most PCBs produced in the United States originated as one of several products called "Aroclors." The major materials produced were Aroclors 1242, 1248, 1254, and 1260. The last two digits designate the percentage of chlorine by weight in the Aroclor (Schwartz and Stalling 1991). It has been observed that the most toxic PCB are coplanar, with chlorine substitution in both para positions, in two or more of the four meta positions, and in less than three of the four ortho positions. (Schwartz and Stalling 1991.) PCB are noted for their propensity to accumulate in biological tissue; bioconcentration factors of >80,000 have been observed (RPI International, Inc. 1989). In addition, the more toxic congeners tend to accumulate preferentially (McFarland 1992, Jones et al. 1994). The primary proposed mode of action for PCBs and other polyhalogenated organic compounds involves binding with the Ah-r receptor. The resulting receptor ligand complex binds to DNA and causes changes in gene expression. (Ludwig et al. 1993, Geisy et al. 1994). While this does not cause an acute toxic response, it can lead to chronic reproductive effects in birds, including embryo mortality and deformity, porphyria, and wasting syndrome (Ludwig et al. 1993, Jones et al. 1994). Biochemical effects observed include induction of cytochrome P450 mixed function oxygenase enzymes (MFOs), depletion of thyroid and steroid hormones, and depletion of hepatic reserves of retinoids and vitamin A (Schwartz and Stalling 1991, Geisy et al. 1994, Jones et al. 1994) Mac et al. (1993) observed increased a correlation between embryonic mortality of trout and the concentrations of total PCBs in both the eggs and adults. The NYSDEC has set a sediment guideline level of concern for human health bioaccumulation of 0.0008 μg of PCB per gram of sediment organic carbon and a wildlife bioaccumulation level of 1.4 μg of PCB per gram of sediment organic carbon. The concentrations observed at CPSC 303A and 305A were 0.3414 and 0.6369 μg/g of organic carbon, respectively. However, the PCB concentrations on a bulk sediment basis in these samples, 32 ppb in 303A and 20 ppb in 305A, were lower than the lowest potential for biological effects of this contaminant sorbed to sediment as suggested by the NOAA (50 ppb) (Long and Morgan 1990).

Although several organochlorine pesticides were found at sample point CPSC 307A, the most important compound identified there and throughout the refuge was DDT and its degradates. DDT was an insecticide with widespread use until it was banned in the United States in 1972. The degradation product DDE inhibits eggshell formation, resulting in thin shelled eggs which break prematurely (Grolier 1988). DDT and its degradates are listed by the USEPA among 129 priority pollutants (Keith et al. 1979). NOAA determined that the potential for biological effects of total DDT contaminants was highest in sediments where concentrations exceeded 350 ppb, with a lowest observed effect level of 3 ppb (Long and Morgan 1990). Only point 305A had no observed DDT residues. The highest was CPSC 307A, with a total DDT concentration of 5,933 ppb. In addition, CPSC 307A exceeded the NOAA maximum effects thresholds for the individual compounds DDT, DDD, and DDE. In addition, the NOAA maximum observed effects threshold for DDD was exceeded at CPSC 303A and 304A, and the NOAA maximum observed effects threshold for DDE was exceeded at CPSC 303A, 304A, and 306A. The NYSDEC guideline levels of concern are based on concentration in sediment organic carbon, rather than bulk sediment. The NYSDEC level of concern for human health bioaccumulation (0.01 μg/g organic carbon) was exceeded in all of the Conscience Point sediment samples except for CPSC 305A. The NYSDEC wildlife bioaccumulation level of concern (1.0 μg/g organic carbon) was exceeded in samples CPSC 306A and 307A, and was approached in sample 304A. The NYSDEC benthic aquatic life chronic toxicity level of concern (1.0 μg DDT/g organic carbon) was exceeded at sample point CPSC 307A.

Thirteen of the 26 PAH detected are listed among 129 priority pollutants by the USEPA (Keith et al. 1979). Higher molecular weight PAH are some of the most carcinogenic chemicals known to man. Many PAH and several of their breakdown products have been documented to be carcinogenic, teratogenic, and mutagenic to a variety of fish and wildlife species (Eisler 1987). PAH usually make up 10 to 30% of crude oil and waste crankcase oil (Hoffman et al. 1982) with used motor oil typically having much higher concentrations than new motor oil (Eisler 1987). Naphthalene, benzo(a)pyrene, fluorene, and phenanthrene are common PAH components of used motor oil (Hoffman et al. 1982). Highly elevated concentrations of PAH in the environment are usually the result of contamination from petroleum products, industrial activities, storm water runoff, sewage outfalls, and atmospheric deposition (Eisler 1987). Toxicities caused by PAH in bivalves appear to be due to disruption of lysosomal structure and loss of lysosomal enzyme function in the digestive tract (McFarland 1995). None of the PAH compounds were detected in the Conscience Point NWR sediment samples at concentrations above the lowest biological effects level (Long and Morgan 1990) or the NYSDEC level of concern (NYSDEC 1993). However, the total concentration of PAH reported for the tissue sample CPTC 309A, 3488.1 ppb, is comparable to the level achieved by bivalves exposed to contaminated sediment from a turning basin in Oakland Inner Harbor, California, in a 28 day laboratory experiment (McFarland 1995). This level is believed high enough to cause lysosomal toxicity (McFarland 1995).

Aliphatic hydrocarbons are a component of motor oil and other petroleum products. Like PAH, high aliphatic concentrations can indicate petroleum contamination, whether from direct spillage, sewage outfalls, or storm water runoff (Coates et al. 1986). Sediment from CPSC 303A generally had higher concentrations of aliphatic hydrocarbons than did CPSC 307A.

Morton NWR

Sediment collected from Morton NWR in 1993 had levels of copper, cadmium, chromium, nickel, and lead exceeding at least one of the concern levels reviewed. The concentration of the PAH chrysene at MTSC 310A exceeded NYSDEC concern levels, at a concentration of 1.05 μg/g of organic carbon. Total PCB concentrations exceeded the NYSDEC sediment guidelines level of concern for human bioaccumulation at two of the sampling points at Morton NWR. Among the organochlorine insecticides, chlordane was detected at concentrations exceeding all of the NYSDEC sediment guidelines level of concern at one location. However, DDT residues turned up at most locations and in one instance reached concentrations in excess of the NYSDEC sediment guidelines level of concern for chronic toxicity to benthic aquatic life as well as the level of concern for wildlife bioaccumulation. Samples MTSC 308 and 311 were soil samples; no levels of concern have been established for upland soils.

The NYSDEC level of concern for cadmium was exceeded at MTSC 301B (0.9 ppm), 305A (1.5 ppm), 306B (1.6 ppm), 307B (0.66 ppm), and 310B (1.7 ppm). The NYSDEC level of concern for chromium and copper were exceeded only at MTSC 310B (29.55 ppm chromium, 16.96 ppm copper). The effects of these metals were discussed above.

Nickel is listed by the USEPA as one of 129 priority pollutants (Keith et al. 1979). Little information is available on the effects of nickel body burdens on fish and wildlife, but experimental doses of nickel have induced cancer in rats, guinea pigs, and rabbits (USEPA 1980b). Mixtures of nickel, copper, and zinc produced additive toxicity effects on rainbow trout *(Oncorhynchus mykiss)* (Rompala et al. 1984). The potential for bioaccumulation of nickel appears to be high to very high for mollusks, crustacea, lower animals, mosses, lichens, algae, and higher plants (Jenkins 1981). Concentrations of nickel ranged from <5 to 19.5 μg/g. NOAA determined that the potential for biological effects was highest in sediments where its concentration exceeded 50 μg/g and was lowest in sediments where its concentration was less than 30 μg/g (Long and Morgan 1990). The IJC suggested sediment concentrations not exceed background levels of 32.3 μg/g (Ingersoll and Nelson 1989). The concentration proposed by NYSDEC as the lowest biological effect level is 16 μg/g, with a severe effect level of 50 μg/g (NYSDEC 1993). MTSC 304B exceeded the NYSDEC level of concern, with a concentration of 16.55 μg/g.

Lead is listed by the USEPA as one of 129 priority pollutants (Keith and Telliard 1979). Lead is a heavy metal which is very toxic to aquatic organisms, especially fish (Rompala et al. 1984). Benthic fish may accumulate lead directly from the sediments (Munawar et al. 1984). Lead also tends to bioaccumulate in mussels and clams (Schmitt et al. 1987, Munawar et al. 1984). All measured effects of lead on living organisms are adverse, including those negatively affecting survival, growth, learning, reproduction, development, behavior, and metabolism (Eisler 1988). Effects of sublethal concentrations of lead include mucous formation, delayed embryonic development, suppressed reproduction, inhibition of growth, and fin erosion (Rompala et al. 1984). In vertebrates, sublethal lead poisoning is characterized by neurological problems (including blockage of acetylcholine release), kidney dysfunction, enzyme inhibition, and anemia (Leland and Kuwabara 1985). In birds, lead has also been implicated in decreases in eggshell thickness, growth, ovulation, and sperm formation (Rompala et al. 1984). Typical sources of lead include atmospheric fallout from motor vehicle and smelter emissions as well as sewage sludge, batteries, pipes, glazes, paints, and alloys. The lowest potential for biological effects of this contaminant sorbed to sediment as suggested by the NOAA is 35.0 μg/g (Long and Morgan 1990). The guideline suggested by the NYSDEC (1993) (31.0 μg/g), as well as the level considered by the IJC to be background for Great Lakes sediment (27.5 μg/g) (Ingersoll and Nelson 1989) was exceeded only in sample MTSC 304B.

Concentrations of total PCB in samples 306A and 307A from Morton NWR were several orders of magnitude greater than the NYSDEC sediment guidelines level of concern for human health bioaccumulation. The concentrations observed at CPSC 306A and 307A were 0.81755 and 0.17898 μg/g of organic carbon, respectively. However, the PCB concentrations on a bulk sediment basis in these samples, 30 ppb in 306A and 12 ppb in 307A, were lower than the lowest potential for biological effects of this contaminant sorbed to sediment as suggested by the NOAA (50 ppb) (Long and Morgan 1990). The nature and effects of PCB were discussed above.

Among the organochlorine pesticides, only chlordane and DDT were found at Morton NWR. Chlordane is a cyclodiene organochlorine pesticide. Like DDT, it is persistent and accumulates readily in fatty tissues. On an acute basis, chlordane is neurotoxic. Raptors are most likely to be poisoned by chlordane as it biomagnifies through the food chain and may reach lethal concentrations in the bodies of top predators (Blus 1995). The concentration of chlordane at sample point MTSC 304A was very high (1.5 μg/g OC), exceeding the NYSDEC guideline levels of concern for human and wildlife bioaccumulation, as well as the levels of concern for chronic and acute benthic toxicity. Chlordane was not detected at any other sample point.

DDT and its degradates were more widespread. Points MTSC 303A, 305A, 309A, and 310A had no observed DDT residues. The highest concentration was in sample MTSC 304A, with a total DDT concentration of 6,332 ppb. However, sample MTSC 306A also had a total DDT residue concentration of 6,254 ppm. MTSC 304A and 306A exceeded the NOAA maximum effects thresholds for the individual compounds DDT, DDD, and DDE by several orders of magnitude. In addition, the NOAA maximum observed effects threshold for DDD was exceeded at MTSC 301A, 302A, and 307A, and the NOAA maximum observed effects threshold for DDE was exceeded at MTSC 302A and 307A. The NYSDEC level of concern for human health bioaccumulation (0.01 μg/g organic carbon) was exceeded in all of the Morton NWR samples where DDT residues were detected. The NYSDEC wildlife bioaccumulation level of concern (1.0 μg/g organic carbon) was exceeded in samples CPSC 302A, 304A, 306A, and 307A, and was approached in sample 301A. The NYSDEC benthic aquatic life chronic toxicity level of concern (1.0 μg DDT/g organic carbon) was exceeded by several orders of magnitude at sample points MTSC 304A and 306A.

Thirteen of the 34 PAH detected are listed among 129 priority pollutants by the USEPA (Keith et al. 1979). Of the PAH compounds detected in the Morton NWR sediment samples, none were above the NOAA lowest biological effects level (Long and Morgan 1990). However, the concentrations of benzo(a)pyrene (0.97 μg/g OC), benzo(b)fluoranthene (0.81 μg/g OC), and chrysene (1.01 μg/g OC) exceed the NYSDEC level of concern for human health bioaccumulation in salt water (0.7 μg/g OC) (NYSDEC 1993). The total concentration of PAH reported for the tissue sample MTTC 309A, 3740.34 ppb, is comparable to the level achieved by bivalves exposed to contaminated sediment from a turning basin in Oakland Inner Harbor, California, in a 28 day laboratory experiment (McFarland 1995).

Lido Beach WMA

Sediment collected from Lido Beach WMA in 1993 had levels of arsenic, copper, cadmium, chromium, mercury, nickel, and lead exceeding at least one of the concern levels reviewed. The concentration of several PAH at LBSC 303A exceeded NYSDEC concern levels. Total PCB concentrations exceeded the NYSDEC sediment guidelines level of concern for human bioaccumulation at two of the sampling points at Lido Beach WMA. Among the organochlorine insecticides, chlordane, dieldrin, and DDE were detected at concentrations exceeding the NYSDEC sediment guidelines level of concern for human bioaccumulation. However, pesticide residues were much lower at Lido Beach WMA than at Conscience Point NWR and Morton NWR. Sample LBSC 302 was a soil sample; no levels of concern have been established for upland soils.

The NYSDEC level of concern for arsenic was exceeded at LBSC 303B (7.59 ppm), 304B (7.62 ppm), and 305B (9.84 ppm). The level of concern for cadmium was exceeded only at LBSC 304B (0.98 ppm). The NYSDEC level of concern for chromium and copper were exceeded at all points except LBSC 306B. Concentrations exceeding the level of concern ranged from 26.77-33.85 ppm. The NYSDEC level of concern for copper was exceeded at LBSC 303B (17.59 ppm) and 307B (17.99 ppm). The

NYSDEC level of concern for nickel was exceeded at LBSC 303B (24.58 ppm), 304B (17.86 ppm), 305B (18.99 ppm), and 307B (24.42 ppm). The NYSDEC level of concern was exceeded at points LBSC 303B and 304B, at concentrations of 51.01 ppm and 40.54 ppm, respectively. The effects of these metals were discussed above.

Mercury is listed by the USEPA as one of 129 priority pollutants (Keith and Telliard 1979). Mercury has a melting point of 3.33°C which makes it the only metallic element that is liquid at room temperature, and its volatility tends to reduce its concentration in surface water (Schmitt et al. 1987). It is one of the few metals which strongly bioconcentrates and biomagnifies; has only harmful effects with no useful physiological functions when present in fish and wildlife; is a carcinogen, mutagen, and teratogen; and is easily transformed from a less toxic inorganic form to a more toxic organic form in fish and wildlife tissues (Eisler 1987). When exposed to mercury in both mediums, fish accumulate more mercury from sediments than from water (Munawar et al. 1984). Plants take up mercury from soil, ground water, sewage sludge, biocides, fertilizers, and air pollution. Animals accumulate mercury from industrial sources, contaminated water, and contaminated food (Jenkins 1981). Sources of mercury include batteries, vapor discharge lamps, thermometers, older-style seals in sewage treatment plants, sewage treatment plant discharges, the chloralkali industry, paints, pesticide compounds, switches, valves, dental labs and offices, pharmaceuticals, scientific and analytical laboratories, soil erosion, and air pollution deposition from fossil fuel combustion and smelters (Eisler 1987). Leachates of municipal landfills contain mercury (Lu et al. 1982). The lowest potential for biological effects of this contaminant sorbed to sediments suggested by the NOAA and the NYSDEC is 0.15 μg/g (Long and Morgan 1990, NYSDEC 1993). The mercury concentration in sample LBSC 304B (0.175 μg/g) was slightly greater than this lowest potential biological effect level. In three of the samples, LBSC 303B, 304B, and 305B, mercury was detected at levels which were greater than the concentration which is considered by the IJC to be background for Great Lakes sediments (0.03 μg/g) (Ingersoll and Nelson 1989). These samples from Lido Beach were the only ones where mercury was above the detection limit (>0.1 ppm) in this study.

Concentrations of total PCB in samples 301A and 306A from Lido Beach were several orders of magnitude greater than the NYSDEC sediment guidelines level of concern for human health bioaccumulation. The concentrations observed at CPSC 301A and 306A were 1.03615 and 1.83281 μg/g of organic carbon, respectively. The concentration at sample point 306A also exceeded the NYSDEC guideline for wildlife bioaccumulation. However, the PCB concentrations on a bulk sediment basis in these samples, 7 ppb in 301A and 9 ppb in 306A, were lower than the lowest potential for biological effects of this contaminant sorbed to sediment as suggested by the NOAA (50 ppb) (Long and Morgan 1990). The nature and effects of PCB were discussed above.

Among the organochlorine pesticides, chlordane, dieldrin, nonachlor, heptachlor, and DDE were found at Lido Beach WMA. Sample point LBSC 302A had the greatest variety of residues, including alpha-, gamma-, and oxy-chlordane, cis- and trans-nonachlor, dieldrin, and heptachlor epoxide. As this was a soil sample, however, it is unclear whether these detections exceeded any level of concern. No DDT residues were found at this point, indicating the terrestrial nature of the sample. The concentration of dieldrin at sample point LBSC 306A (0.58 μg/g OC) exceeded the NYSDEC guideline levels of concern for human. DDE was the only DDT residue identified at Lido Beach, and concentrations and frequency of detection were lower than at other LINWRC units. Points LBSC 304A and 306A had DDE concentrations of 0.17 μg/g OC and 0.54 μg/g OC, respectively. This exceeds the NYSDEC level of concern for human health bioaccumulation. On a bulk sediment basis, the DDE concentrations in these samples were 3-5 ppb, which exceed the NOAA lowest effects threshold of 2 ppb, but are well below the maximum effects threshold of 15 ppb (Long and Morgan 1990).

Thirteen of the 35 PAH detected are listed among 129 priority pollutants by the USEPA (Keith et al. 1979). Of the PAH compounds detected in the Lido Beach WMA sediment samples, none were above the NOAA lowest biological effects level (Long and Morgan 1990). However, the concentrations of benzo(a)pyrene (1.54 μg/g OC), benzo(b)fluoranthene (1.18 μg/g OC), benzo(k)fluoranthene (1.18 μg/g OC), chrysene (1.54 μg/g OC), and indeno(1,2,3-cd)pyrene (0.866 μg/g OC) exceed the NYSDEC level of concern for human health bioaccumulation in salt water (0.7 μg/g OC) (NYSDEC, 1993). The total concentration of PAH reported for the tissue sample LBTC 309A, 6897.1 ppb, is comparable to the highest level achieved by bivalves exposed to contaminated sediment from a turning basin in Oakland Inner Harbor, California, in a 28 day laboratory experiment (McFarland 1995).

Sayville Unit

As there are no readily accepted criteria for contaminant levels in soil, the contaminant levels at the Sayville Unit cannot be compared to those at the other refuges. The inorganic contaminant burdens in soil samples collected from Sayville in 1993 were within or below Long Island soil ranges (Cappelli, pers. comm.). PAH concentrations at Sayville were higher than at other locations, including the highest concentrations of benzo(a) pyrene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene. Total PCB concentrations were low; no sample had total PCB residues above the limit of detection. Among the organochlorine insecticides, only DDE and DDT were detected at Sayville. Concentrations were comparable to those at Conscience Point NWR and Morton NWR, and somewhat higher than those at Lido Beach WMA.

Microtox® Testing of Elutriate and Sediment

Of the 12 elutriate samples exhibiting toxicity, seven came from Conscience Point NWR. A sample from Conscience Point exhibited the greatest toxicity of all samples (Sample CPMTX03B, from the tidal pool in the northwest Marsh Area). It is not clear why the Conscience Point samples exhibited greater toxicity than those from Morton NWR and Lido Beach WMA. As the Microtox® test material did not come from the analytical samples, it is not possible to compare the analytical contaminant concentrations in a given sample with the toxic response for a sample from the same general area in the Microtox® test. The analytical results from sample CPSC 303A and 303B, taken from the same area as CPMTX03B, do not indicate exceptionally high concentrations of any particular contaminant or class of contaminants which could account for the Microtox® results.

Ribbed Mussels Collected in the LINWRC

Ribbed mussels are generally 75 to 100 mm in length and commonly found on the Atlantic Coast. They live on tidal banks and flats, or in salt marshes, buried in muddy or peaty bottom sediments. Only the posterior edge shows above the bottom. The ribbed mussel is said to thrive best under partially polluted conditions (Morris 1973). Eleven of the ribbed mussel composite samples collected at Conscience Point NWR, Morton NWR, and Lido Beach WMA exceeded the predator protection levels for arsenic, 0.5 μg/g (Walsh et al. 1977), cadmium, 0.5 μg/g, chromium, 0.2 μg/g (Eisler 1986) mercury, 0.1 μg/g (Eisler 1987), and selenium, 0.5 μg/g (Walsh et al. 1977). The effects and sources of all of these except selenium have been discussed previously. Selenium is listed by the USEPA as one of 129 priority pollutants (Keith and Telliard 1979). Selenium has many teratogenic and toxic impacts upon fish and wildlife at high concentrations (Eisler 1985). Waterfowl feeding on zooplankton or on algae may be more sensitive to selenium contamination than those feeding on seeds (Lillebo et al. 1986). Selenium is required in minute quantities to maintain tissue elasticity and prevent premature aging, muscle pain, and heart disease in humans (American Medical Association 1989). The range between insufficient selenium in the diet of animals and too much is narrow, and the effects of either problem can be serious (Lemly and Smith 1987). Excessive amounts of selenium include birth defects, sterility, and death. In humans, excessive amounts of selenium have reportedly caused baldness, loss of nails and teeth, fatigue, and death (American Medical Association 1989). Plants take up selenium from soil, groundwater, sewage sludge, and air pollution. Animals take up selenium from industrial sources, air pollution, water, and food (Jenkins 1981). Other than areas impacted by agricultural drainage, very high concentrations of selenium in fish and wildlife occur primarily in areas where selenium is naturally high in the soils, where there is an influence of sewage sludge, or where coal fired power plants are present (Eisler 1985, Haywood and Ohmart 1986). Selenium is used in photocopying, glass manufacturing, the production of stainless steel, fungicides, lubricants, electronic devices, pigments, dyes, insecticides, veterinary medicine, the production of photocells, exposure meters, and solar cells (USEPA 1980c, Friberg et al. 1979, Kerr 1988).

Among the organic pollutants, the only established predator protection level is for PCB, at 0.5 ppm in the aquatic environment. This level was only exceeded in Conscience Point sample 310A, at 0.54 ppm. Only one other sample, Lido Beach 308A, had a PCB concentration above the limit of detection.

Surprisingly, the only invertebrate sample containing measurable residues of DDT was obtained from Lido Beach 309A. Sediment concentrations of DDT residues at Lido Beach were generally lower than those at Morton and Conscience Point.

Aliphatic hydrocarbons and PAH were also detected in the invertebrate samples. Among the aliphatic hydrocarbons, cosane concentrations (straight chain organic compounds containing from 20-29 carbon atoms) in tissue tended to be comparable to sediment values. Decane (straight chain organic compounds with 10-19 carbon atoms) and contane (30 or more carbon atoms) concentrations were generally one order of magnitude greater in tissue than in sediment. The alkane n-dodecane (12 carbon atoms) bioconcentrated some 100x above sediment values, more than any other compound in this group. PAH values were generally higher, in many cases biomagnifying by one order of magnitude from the surrounding sediment, and in some cases increasing by two orders of magnitude. The naphthalenes appeared to be more likely to accumulate than any other class of PAH. Given the greater variety of PAHs observed in sediment than in invertebrate tissue, it appears that ribbed mussels may have the capacity to metabolize and/or excrete many PAH compounds. None of the specific PAH listed in the NYSDEC sediment guidelines were found in measurable quantities in ribbed mussels.

Fish Tissue Collected at Morton NWR

Finfish from the families Belonidae, Cyprinodontidae, and Atherinidae are commonly known as needlefish, killifish, and silversides, respectively (McClane 1978). Needlefish live at the surface. They feed heavily on small fishes. Seven species are known from the western North Atlantic. Killifish are small schooling fish of shallow coastal waters. They can tolerate a wide range of temperature and salinity, and can live in water of extremely poor quality. Some species are fairly long-lived, and do not reach maturity for two to three years (Hardy 1978). Silversides are small fish with similar distribution to killifish, and are important forage fish. Silversides generally live less than two years. They are opportunistic omnivores, consuming a variety of invertebrates, fish eggs, and algae (Fay et al. 1983). The fish tissue collected at Morton NWR exceeded the predator protection levels suggested for arsenic, 0.5 μg/g (Walsh et al. 1977), chromium, 0.2 μg/g (Eisler 1986), mercury, 0.1 μg/g (Eisler 1987), and selenium, 0.5 μg/g (Walsh et al. 1977). The tissue also exceeded the predator protection level for mink, 0.1 μg/g, where mink is used as an example of a contaminant sensitive predator. The effects and sources of these contaminants have been discussed previously.

CONCLUSIONS

The 1993 sediment and tissue sampling at Conscience Point NWR, Morton NWR, Lido Beach WMA, and the Sayville Unit indicate pervasive low-level contamination, similar to results found at Oyster Bay NWR and Wertheim NWR in 1990 and 1991. There is a transport of contaminants onto these refuges. On Conscience Point NWR, the northwest salt marsh area and the embayment immediately to the north of this salt marsh (CPSC samples 303 and 305) may be considered a contaminant sink, generally containing the maximum contamination on the refuge. Contaminants appear to be more evenly distributed at the other study units.

The biological uptake of contaminants in these refuges, and their transport from sediment through invertebrates to forage fish and predators, needs further evaluation. Separate analyses of forage fish and predator fish tissue would be helpful in determining whether contaminant concentrations are magnified up the food chain.

The results of the Microtox® testing suggest that certain locations in the LINWRC have a high residual toxicity. However, contaminant identification is needed in order to understand the sources and potential effects of this observed toxicity.

LITERATURE CITED

American Medical Association. 1989. Home Medical Encyclopedia. Random House, NY, 2 volumes, 1184 pp.

Ames, B.N., R. Magaw, and L.S. Gold. 1987. Ranking possible carcinogenic hazards. Science 236:271-280.

Barrick, R., S. Becker, L. Brown, H. Beller, and R. Pastorok. 1988. Sediment quality values refinement: 1988 update and evaluation of Puget Sound AET. PTI Environmental Services Inc., Bellevue, WA, report to Puget Sound Estuary Program, Region 10 of the USEPA, Seattle, WA, USEPA contract number 68-01-4341, 74 pp. plus appendices.

Blus, L.J. 1995. Organochlorine Pesticides. in Hoffman, D.J., B.A. Rattner, G.A. Burton, Jr., and J. Cairns, Jr., eds. Handbook of Ecotoxicology. Lewis Publishers, Ann Arbor, MI. 755 pp.

Cappelli, J. 1991. U.S. Environmental Protection Agency, Region II, New York, NY.

Coates, M., D.W. Connell, J. Bodero, G.J. Miller, and R. Back. 1986. Aliphatic hydrocarbons in Great Barrier Reef organisms and environment. Estuarine, Coastal, and Shelf Science **23**: 99-113.

Eisler, R. 1985. Selenium hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85/1. 5:1-57.

__________. 1987. Mercury hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85/1. 10:1-90.

__________. 1988. Chromium hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85:1-60.

__________. 1988. Lead hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85/1. 14:1-134.

Emerson, W.K. and M.K. Jacobson. 1976. The American Museum of Natural History Guide to Shells. Alfred A. Knopf. New York. 482 pp.

Fay, C.W., R.J. Neves, and G.B. Pardue. 1983. Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Mid-Atlantic) -- Atlantic Sliverside. U.S. Fish and Wildlife Service Report FWS/OBS-82/11.10. 15 pp.

Fleishman, S. 1988. Chapter on magnesium. In: The Electronic Encyclopedia (TM), the 21 volume Academic American Encyclopedia on CD-ROM, © 1988 Grolier Electronic Publishing, Inc., Danbury, CT.

Friberg, L., G.F. Nordberg, and V.B. Vouk. 1979. Handbook on the Toxicology of Metals. Elsevier/North-Holland Biomedical Press, New York, NY.

Giesy, J.P., J.P. Ludwig, and D.E. Tillitt. 1994. Dioxins, dibenzofurans, PCBs and colonial, fish-eating water birds. *in* Schechter, A., ed. Dioxins and Health. Plenum Press, New York.

Gosner, K.L. 1978. A Field Guide to the Atlantic Seashore. Houghton Mifflin Co. Boston. 329 pp.

Green, M. 1988. Chapter on pollutants, chemical. In: The Electronic Encyclopedia (TM), the 21 volume Academic American Encyclopedia on CD-ROM, © 1988 Grolier Electronic Publishing, Inc., Danbury, CT.

Grolier Electronic Publishing. 1988. Chapter on boron. In: The Electronic Encyclopedia (TM), the 21 volume Academic American Encyclopedia on CD-ROM, © 1988 Grolier Electronic Publishing, Inc., Danbury, CT.

Hardy, J.D. Jr. 1978. Development of Fishes of the Mid-Atlantic Bight: An atlas of egg, larval, and juvenile stages. Volume II: Anguillidae through Syngnathidae. U.S. Fish and Wildlife Service Report No. FWS/OBS-78/12. 455 pp.

Health and Environment Network. 1987. Municipal Solid Waste: Can we landfill it? Health and Environment **1**:1-3.

Hem, J.D. 1985. Study and interpretation of the chemical characteristics of natural water, Third Edition. U.S. Geological Survey Water-Supply Paper 2253. A GPO book for sale by the Distribution Branch, Text Products Section, USGS, Alexandria, VA. 263 pp. (third printing, 1989).

Haywood, D.D. and R.D. Ohmart. 1986. Utilization of benthic-feeding fish by inland breeding bald eagles. The Condor **88**:35-42.

Hoffman, D.J., W.C. Eastin, and M.L. Gay. 1982. Embryotoxic and biochemical effects of waste crankcase oil on bird's eggs. Toxicology and Applied Pharmacology **63**: 230-241.

Ingersoll, C.G. and M.K. Nelson. 1989. Testing sediment toxicity with *Hyalella azteca* (Amphipoda) and *Chironomus riparius* (Diptera). Presented April 16-18 at the ASTM STP 13th Symposium on Aquatic Toxicology Risk Assessment, Atlanta, GA, 43 pp. Available from Chris Ingersoll or Marsha Nelson, FWS, National Fisheries Contaminant Research Center, Columbia, MO. 65201.

Jenkins, D.W. 1981. Biological Monitoring of Toxic Trace Elements. USEPA Report 600/S3-80-090:1-9.

Jones, P.D., J.P. Giesy, J.L. Newsted, D.A. Verbrugge, J.P. Ludwig, M.E. Ludwig, H.J. Auman, R. Crawford, D.E. Tillitt, T.J. Kubiak, and D.A. Best. 1994. Accumulation of 2,3,7,8-tetrachlorodibenzo-p-dioxin equivalents by Double-Crested Cormorant (*Phaloacrocorax auritus,* Pelicaniformes) chicks in the North American Great Lakes. Ecotoxicology and Environmental Safety, **27**, 192-209.

Keith, L.H. and W.A. Telliard. 1979. Priority Pollutants: I - a perspective view. Eniviron. Sci. and Toxicol. **13**:416-423.

Keller, P.C. 1988. Chapter on zinc. In: The Electronic Encyclopedia (TM), the 21 volume Academic American Encyclopedia on CD-ROM, © 1988 Grolier Electronic Publishing, Inc., Danbury, CT.

Kerr, J.A. 1988. Chapter on vanadium. In: The Electronic Encyclopedia (TM), the 21 volume Academic American Encyclopedia on CD-ROM, © 1988 Grolier Electronic Publishing, Inc., Danbury, CT.

Leland, H.V. and J.S. Kuwabara. 1985. Chapter 13, Trace Metals. In Rand, G.M. and S.R. Petrocelli (eds.) Fundamentals of Aquatic Toxicology. Hemisphere Publishing Company, NY, 666 pp.

Lemly, A.D. and G.J. Smith. 1987. Aquatic cycling of selenium: implications for fish and wildlife. U.S. Fish and Wildlife Service Leaflet **12**:1-10.

Lillebo, H.P., S. Shaner, D. Carlson, N. Richard, and P. Dubowy. 1986. Report to the "85-1" committee: water quality criteria for selenium and other trace elements for protection of aquatic life and its uses in the San Joaquin Valley. Division of Water Quality, State Water Resources Control Board, State of California, Sacramento, CA: pages 1-64.

Long, E. and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the national status and trends program. NOAA Technical Memorandum NOS OMA 52, National Ocean Service, Seattle, WA. 175 pp.

Lu, J.C, B. Eichenberger, and R.J. Stearns. 1982. Leachate from Municipal Landfills. Noyes Publications, Park Ridge, NJ.

Ludwig, J.P., J.P. Giesy, C.L. Summer, W. Bowerman, R. Aulerich, S. Bursian, H.J. Auman, P.D. Jones, L.L. Williams, D.E. Tillitt, M. Gilbertson. 1993. A comparison of water quality criteria for the Great Lakes based on human and wildlife health. Journal of Great Lakes Research. 19, pp. 789-8

Mac, M.J., T.R. Schwartz, C.C. Edsall, and A.M. Frank. 1993. Polychlorinated biphenyls in Great Lakes trout and their eggs: relations to survival and congener composition 1979-1988.

Mann, D.P. and K. Karwowski. 1991. Preliminary assessment of the Long Island National Wildlife Refuge Complex environmental contaminants background survey. U.S. Fish and Wildlife Service, New York Field Office, Cortland, NY. 49 pp.

McClane, A.J. 1978. Field Guide to Saltwater Fishes of North America. Holt, Rinehart, and Winston. New York. 283 pp.

McFarland, V.A.; Reilly, F.J.; Clarke, J.U.; Ferguson, P.W. 1992. Dioxin Toxic Equivalents (TEQs) in Dredged Sediment Evaluation . Water Quality '92: Proceedings of the 9th Seminar. Proceedings of a seminar held in San Antonio, Texas; 16-20 March 1992. Environmental Laboratory, Army Engineers Waterways Experiment Station, Vicksburg, Mississippi. Miscellaneous Paper W-92-3, October 1992. p 207-220.

McFarland, V.A. 1995. Evaluation of field-generated accumulation factors for predicting the bioaccumulation potential of sediment-associated PAH compounds. Technical Report D-95-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 139 pp.

Morris, P.A. 1973. A Field Guide to Shells of the Atlantic and Gulf Coasts and the West Indies. Third Edition. Houghton Mifflin Co. Boston, MA. 330 pp.

Munawar, M., R.L. Thomas, H. Shear, P. McKee, and A. Murdoch. An overview of sediment-associated contaminants and their bioassessment. Canad. Tech. Rep. Fish. Aquatic Sci. **1253**:1-136.

National Academy of Sciences. 1973. Section III-freshwater aquatic life and wildlife, water quality criteria. Ecological Research Series, EPA-R3-73-033: 106-213.

National Library of Medicine. 1988. Hazardous Substances Data Bank (HSDB). In: "HSDB" electronic database as reproduced in the Tomes Plus (TM) CD-ROM data base Vol. 7, Micromedex Inc., Denver, CO.

New York State Department of Environmental Conservation. 1989. Sediment Criteria - December 1989. Used as guidance by the Bureau of Environmental Protection, Division of Fish and Wildlife, New York State Department of Environmental Conservation, Albany, NY.

Norton, D.J., J. Organ, and T. Litwin. 1984. Habitat classification and covertype mapping of the Long Island National Wildlife Refuge Complex. U.S. Fish and Wildlife Service Report. 115 pp.

RPI International, Inc. 1989. Natural Resource Response Guide: Marine shellfish. National Oceanic and Atmospheric Administration. Silver Spring, MD. 86 pp.

Rompala, J.M., F.W. Rutosky, and D.J. Putnam. 1984. Concentrations of environmental contaminants from selected waters in Pennsylvania. U.S. Fish and Wildlife Service report. State College, PA.

Shacklett, H.T., J.C. Hamilton, J.G. Boerngen, and J.M. Bowles. 1971. Elemental composition of surficial materials in the conterminous United States. U.S. Geological Survey Professional Paper 574-D. U.S. Government Printing Office, Washington, DC. 71 pp.

Shaw, T.L. 1993. Conscience Point, Lido Beach, and Morton Beach elutriate and Sediment Toxicity Tests Using the Microtox® System. Unpublished study. 15 pp.

Schmitt, C.J. and S.E. Finger. 1987. The effects of sample preparation on measured concentrations of eight elements in edible tissues of fish from streams contaminated by lead mining. Arch Environ. Contam. Toxicol. **16**:185-207.

Schmitt, C.J., S.E. Finger, T.W. May, and M.S. Kaiser. 1987. Bioavailability of lead and cadmium from mine tailings to the pocketbook mussel. Proceedings of the workshop on die-offs of freshwater mussels in the U.S., Richard J. Neves, Editor, U.S. Fish and Wildlife Service, Columbia, MO.

Schwartz, T.R., Stalling, D.L. 1991. Chemometric comparison of polychlorinated biphenyl residues and toxicologically active polychlorinated biphenyl congeners in the eggs of Forster's terns *(Sterna forsteri)*. Archives of Env. Contam. Toxicol. 20, 183-199.

Spinella, A.G., J.H. Nakao, R. Busciolano, R.B. Winowitch, and V.K. Eagen. 1992. Water Resources Data New York Water Year 1991: Volume 2. Long Island. U.S. Geological Survey Water-data Report NY-91-2. This report may be purchased from the National Technical Information Service, Springfield, VA.

U.S. Environmental Protection Agency. 1980a. Ambient water quality criteria for copper. USEPA Report 440/5-80-036. National Technical Information Service, Springfield, VA.

__________. 1980b. Ambient water quality criteria for nickel. USEPA Report 440/5-80-060. National Technical Information Service, Springfield, VA.

__________. 1980c. Ambient water quality criteria for selenium. USEPA Report 440/5-80-070. National Technical Information Service, Springfield, VA.

__________. 1983. Process design manual for land concentration of municipal sludge. USEPA, Cincinnati, OH.

__________. 1986. Quality criteria for water. USEPA Report 440/5-86-001. Office of Water Regulations and Standards, Washington, DC.

Walsh, D.F., B.L. Berger, and J.R. Bean. 1977. Mercury, arsenic, lead, cadmium, and selenium residues in fish. 1971-1973-National Pesticide Monitoring Program. Pestic. Monit. J. 11:5-34.

Wood, R. and W.L. Gelston. 1972. Preliminary report: the Mute Swans of Michigan's Grand Traverse Bay region. Mich. Dep. Nat. Resour. Rep. 2683. 6 pp.

Appendix A

New York Field Office (DM/KK - 6/92)
(607) 753-9334

STANDARD OPERATING PROCEDURE FOR COLLECTION OF WATER AND SEDIMENT FOR ANALYSIS

Prior to field collection:

1. Prepare labels, Chain of Custody, and Sample Inventory Forms:
   Labels should be simple: include sample ID (8 characters or less) and sample date.

2. Assemble chemically clean sample containers (depends upon tests to be performed and lab specifications).

   One container each for:

   a. Biochemical Oxygen Demand, 500ml water in plastic
   b. Chemical Oxygen Demand/Ammonia, 500ml water in plastic
   c. Sediment-Pore Water Bioassay, 4000ml sediment in glass
   d. Bioassay water (Microtox®), 8000ml water in dark glass

   Two containers each for duplicates for:

   e. Organic contaminant residues, 500ml sediment in glass
   f. Inorganic contaminant residues, 500ml sediment in glass
   g. Duplicate, 500ml sediment in glass

3. Tape labels to the containers to be used for collection, this reduces confusion and work in the field. Wrap tape completely around jar, to prevent loss of labels due to moisture.

4. Sample collection equipment needed:

   a. All stainless steel Ponar dredge
   b. Stainless steel soil auger (backup sampler)
   c. Stainless steel kemmerer bottle with teflon stops
   d. Stainless steel buckets
   e. Stainless steel pans (to set dredge in)
   f. Stainless steel spoons and ladles

g. Nylon bristle brushes with plastic handles
h. Water chemistry measuring equipment (dissolved oxygen, temperature, pH and conductivity meters)
I. Coolers and ice (enough to hold all samples)
j. Assortment of plastic bags (Ziploc and twist-tie types)

5. DECON of sampling equipment: To be done initially and between each sampling sites:

   a. Scrub equipment with detergent solution
   b. Rinse with water (tap or stream acceptable)
   c. Rinse twice with distilled water
   d. Rinse with 10% Nitric acid
   e. Rinse thoroughly with distilled water
   f. Rinse with acetone
   g. Allow to air dry
   h. Cover with aluminum foil

<u>At collection site</u>:

1. Collect water chemistry data, 3 rounds of readings or automatic readings for a designated amount of time, are suggested. Rinse probes with distilled water after readings are completed.

2. Collect all water samples first with kemmerer just above sediment level or with grab samples taken at least 12 inches below surface. (leave no head space)

3. Collect a composite sediment sample with the ponar dredge or soil auger taking at least 5 grabs and place in bucket, rest dredge in pan while resetting. Try to select a site which has silt or clay sediment type.

4. Homogenize sediment in bucket with spoon or stainless steel auger and cordless drill. Wear disposable gloves and avoid contact with the sediment.

5. Fill sample containers: leaving no head space for bioassay samples and filling maximum of 3/4 for residue samples. Tape cap on with a durable tape then place on ice.

6. DECON equipment between sampling sites (if a base station can be set up, steps 4 and 5 can be done there).

7. DECON and store equipment after sampling has been completed.

Appendix B

Metals:

Al
As
B
Be
Cd
Cr
Cu
Fe
Hg
Mg
Mn
Mo
Ni
Pb
Se
Sr
V
Zn

PAH:

1,2,5,6-dibenzanthracene
1,2-benzanthracene
1,6,7-trimethylnaphthalene
1-methylphenanthrene
2,6-dimethylnaphthalene
2-methylnaphthlene
C1-fluoranthenes & pyrenes
C1-Phenanthrenes & anthracenes
C1-chrysenes
C1-dibenzothiophenes
C1-fluorenes
C1-naphthalenes
C2-phenanthrenes & anthracenes
C2-chrysenes
C2-dibenzothiophenes
C2-fluorenes
C2-naphthalenes
C3-phenanthrenes & anthracenes
C3-chrysenes
C3-dibenzothiophenes
C3-fluorenes

C3-naphthalenes
C4-phenanthrenes & anthracenes
C4-chrysenes
C4-naphthalenes
acenaphthalene
anthracene
benzo(a)pyrene
benzo(b)fluoranthene
benzo(e)pyrene
benzo(g,h,i)perylene
benzo(k)fluoranthene
biphenyl
chrysene
fluoranthene
fluorene
indeno(1,2,3-cd) pyrene
perylene
phenanthrene
phytane
pristane
pyrene
naphthalene

PCB:

7
8
15
16/32
18
22
24
25
26
28
29
33
37/42
40
41/64
44
45
46

47/48
49
50
52
60/56
66
70
74
77
82
83
84
87
88
92
97
99
101
105
107/108/144
110/77
118/108/149
126
128
129
136
137
138
141
146
149
151
153
156/171/202
158
167
170
172
174
177
178
180

183
185
187/182/159
188
189
191
194
195
196
200
201
205
206
209
1242
1248
1254
1260
Total

Organochlorine Pesticides:

alpha-chlordane
gamma-chlordane
oxychlordane
heptachlor epoxide
cis-nonachlor
trans-nonachlor
aldrin
dieldrin
endrin
mirex
hexachlorobenzene
heptachlor
beta BHC
gamma BHC
delta BHC
o,p'-DDD
o,p'-DDE
o,p'-DDT
p,p'-DDD
p,p'-DDE
p,p'-DDT

Aliphatic Hydrocarbons:

n-decane
n-undecane
n-dodecane
n-tridecane
n-tetradecane
n-pentadecane
n-hexadecane
n-heptadecane
n-octadecane
n-nonadecane
n-eicosane
n-heneicosane
n-docosane
n-tricosane
n-tetracosane
n-pentacosane
n-hexacosane
n-heptacosane
n-octacosane
n-nonacosane
n-hentriacontane
n-dotriacontane
n-triacontane
n-tertriacontane